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The Liminality of Man: Astronomy and the Birth of Anthropology in the Eighteenth Century

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Abstract

This essay argues that modern cultural anthropology is a product of early-modern astronomical science. Analyzing a variety of texts from the sixteenth, seventeenth and eighteenth-centuries, this text shows how the conceptual tools that early-modern astronomers developed, beginning in the fifteenth century, were transferred to anthropological thought, during the course of the seventeenth and eighteenth centuries. The end result was an anthropological tradition that this essay calls celestial anthropology. This tradition formed around 1700 and ran, uninterrupted, until 1850, when the astronomical backdrop to anthropological thought receded from discussions about the human being and left behind contemporary anthropological approaches, including above all cultural anthropology. This essay further argues that celestial anthropology lives on in contemporary theology and science writing and concludes that anthropological discussion should pay more attention to the methods and approaches of these heirs to celestial contemplation.

Resumen

El presente ensayo sostiene que la antropología cultural es un producto de la ciencia astronómica de principios de la era moderna. Tras analizar una variedad de textos que datan del siglo XVI, XVII y XVIII, el autor muestra cómo las herramientas conceptuales que desarrollaron los astrónomos al comienzo de la era moderna, fueron luego transferidos al pensamiento antropológico en el transcurso de los siglos XVII y XVIII. Por ello, el presente escrito denomina al resultado como antropología celestial, tradición que se formó alrededor de 1700 y que siguió ininterrumpidamente hasta 1850, cuando el fondo astronómico del pensamiento antropológico se hizo a un lado de las discusiones acerca del ser humano y dejó a un lado los enfoques contemporáneos de la antropología, sobre todo de la antropología cultural. Además, este ensayo arguye que la antropología celestial continúa en la teología contemporánea y la escritura científica, por lo que concluye que la discusión antropológica debería prestar más atención a los métodos y enfoques de estos herederos de la contemplación celeste.

Introduction

> "And *Man* how purblind, if unknown the whole!
> Who circles spacious *Earth*, Then travels *here*,
> Shall own, He was never from *Home* before!"
>
> Edward Young, *The Complaint: or, Night Thoughts on Life, Death and Immortality* (1742-1745)[1]

Contemporary historical work on the birth of anthropology is as diverse and complicated as the anthropological discipline's object of study. The literature is expansive, coming from a variety of areas, while also cutting across many themes and topics. There is no agreement on anthropology's temporal origins. Depending on the scholar, it dates back to the classical world, the early twentieth century, or to one or another century in between.2 Nor is there agreement on how to define anthropology's origins with respect to contemporary academic disciplines, as scholars have traced its birth through

[1] Edward Young, *The Complaint: Or, Night Thoughts on Life, Death, and Immortality* (London: A. Millar, 1750), 316.

[2] For the classical world, see: Clyde Kluckhohn, *Anthropology and the Classics* (Providence, RI: Brown University Press, 1961). For a very useful overview, see Hans Erich Bödeker, "Menschheit, Humanität, Humanismus", in *Geschichtliche Grundbegriffe*, ed. Otto Brunner, Werner Conze, and Reinhart Koselleck (Stuttgart: Klett-Cotta, 1982). On the sixteenth century: Anthony Pagden, *The Fall of Natural Man: The American Indian and the Origins of Comparative Ethnology*, 1st pbk. ed. (Cambridge: Cambridge University Press, 1986), ———, *European Encounters with the New World: From Renaissance to Romanticism* (New Haven: Yale University Press, 1993), ———, *Lords of All the World: Ideologies of Empire in Spain, Britain and France, C. 1500-C. 1800* (New Haven: Yale University Press, 1995). Margaret T. Hodgen, *Early Anthropology in the Sixteenth and Seventeenth Centuries* (Philadelphia, PA: University of Pennsylvania Press, 1964). See also John Huxtable Elliott, *The Old World and the New, 1492-1650* (Cambridge: Cambridge University Press, 1970). On the seventeenth century: Harry Liebersohn, "Anthropology before Anthropology", in *A New History of Anthropology*, ed. Henrika Kucklick (Malden, MA: Blackwell Publishing, 2008). and Alan Barnard, *History and Theory in Anthropology* (Cambridge: Cambridge University Press, 2000). See also Murray Leaf, *Man, Mind, and Science: A History of Anthropology* (New York: Columbia University Press, 1979). which gives credit to Descartes as the source of modern anthropology. Also important in this context are these classic works: Wilhelm Dilthey, "Die Funktion Der Anthropologie in Der Kultur Des 16. Und 17. Jahrhunderts", in *Wilhelm Diltheys Gesammelte Schriften* (Leipzig: B. G. Teubner, 1921)., which puts anthropology into the context of sixteenth- and seventeenth-century philosophy's discovery of the philosophical subject and Jacob Burckhardt, *Die Kultur Der Renaissance in Italien* (Berlin: Deutsche Buch-Gemeinshaft, 1961), 67-85., which is more oriented toward the discovery of the individual, especially the chapter entitled "Entwicklung des Individuums." On the eighteenth century: John H. Zammito, *Kant, Herder, and the Birth of Anthropology* (Chicago: University of Chicago Press, 2002), Mareta Linden, *Untersuchungen Zum Anthropologie Begriff Des 18. Jahrhunderts* (Bern and Frankfurt am Main: Herbert Lang/Peter Lang, 1976), Michèle Duchet, *Anthropologie Et Histoire Au Siècle Des Lumières: Buffon, Voltaire, Rousseau, Helvétius, Diderot* (Paris: Albin Michel, 1995; reprint, Éditions Albin Michel, S.A.). E. E. Evans-Pritchard, *History of Anthropological Thought* (London: Faber and Faber, 1981). On the nineteenth century: George W. Stocking, *Victorian Anthropology* (NewYork: Free Press, 1987), ———, *After Tylor: British Social Anthropology, 1888-1951* (Madison, WI: University of Wisconsin Press, 1995). ———, ed. *Volksgeist as Method and Ethic: Essays on Boasian Ethnography and the German Anthropological Tradition* (Madison, WI: University of Wisconsin Press,1996). See also H. Glenn Penny, *Objects of Culture: Ethnology and Ethnographic Museums in Imperial Germany* (Chapel Hill, NC: University of North Carolina Press, 2002), H. Glenn Penny and Matti Bunzl, eds., *Worldly Provincialism: German Anthropology in the Age of Empire* (Ann Arbor, MI: University of Michigan Press,2003).

aesthetics, anthropology (as defined by anthropologists), literature, medicine, physical science, philosophy, psychology, theater and theology.[3] Finally, there is no agreement on what anthropology —especially the contemporary variety— *is* historically, beyond the recognition that the human being has been an object of study, contemplation and even celebration.

Diversity also reigns among present-day practitioners. There are four separate fields within the discipline —archaeology, anthropological linguistics, biological anthropology and cultural anthropology— with each using methods and posing questions so different that it strains credulity to talk of a single discipline, let alone to project unity backward in time.[4] Cultural anthropology is the most prominent field for scholars from other areas, especially history.[5] (In Europe cultural anthropology is called ethnology, but the distinction is minor.)[6] Regardless of the name applied to it, this field can be defined as the study of cultures and how human beings produce them.

Over the past four decades, cultural anthropologists, such as Keith Thomas, E. E. Evans-Pritchard and Clifford Geertz, have greatly influenced the historical field; it may, therefore, be useful to reflect on whether their methods can be applied to the history of their own discipline.[7] Translating

[3] On aesthetics, see Gabriele Dürbeck, *Einbildungskraft Und Aufklärung: Perspektiven Der Philosophie, Anthropologie Und Ästhetik Um 1750*, Studien Zur Deutschen Literatur, Bd. 148 (Tübingen: M. Niemeyer Verlag, 1998). On literature, Jürgen Barkhoff and Eda Sagarra, eds., *Anthropologie Und Literatur Um 1800* (München: Iudicium,1992), Helmut Pfotenhauer, *Literarische Anthropologie: Selbstbiographien Und Ihre Geschichte, Am Leitfaden Des Leibes* (Stuttgart: Metzler, 1987). On medicine, Alexander Kosenina, *Ernst Platners Anthropologie Und Philosophie: Der 'Philosopische Arzt' Und Seine Wirkung Auf Johann Karl Wezel Und Jean Paul* (Würzburg: Königshausen u. Neumann, 1989). On the natural sciences, Walter Schmitz and Carsten Zelle, *Innovation Und Transfer: Naturwissenschaften, Anthropologie Und Literatur Im 18. Jahrhundert* (Dresden: Thelem bei w.e.b., 2004). Odo Marquard, "Zur Geschichte Des Philosophischen Begriffs "Anthropologie" Seit Dem Ende Des 18. Jahrhunderts", in *Collegium Philosophicum: Studien Joachim Ritter Zum 60. Geburtstag*, ed. Ernst-Wolfgang Böckenförde (Basel: Schwabe & Co., 1965). On philosophy, Arnold Gehlen, "Philosophische Anthropologie", in *Gesamtausgabe*, ed. Lothar Samson (Frankfurt am Main: Vittorio Klostermann, 1978), ———, "Das Menschenbild in Der Modernen Anthropologie", in *Gesamtausgabe*, ed. Lothar Samson (Frankfurt am Main: Vittorio Klostermann, 1978). On psychology, see Soo Bae Kim, *Die Entstehung Der Kantischen Anthropologie Und Ihre Beziehung Zur Empirischen Psychologie Der Wolffschen Schule* (Frankfurt am Main: Peter Lang, 1994). On theater, Wolfgang Lukas, *Anthropologie Und Theodizee: Studien Zum Moraldiskurs Im Deutschsprachigen Drama Der Aufklärung (Ca. 1730 Bis 1770)* (Göttingen: Vandenhoeck & Ruprecht, 2005). On theology, Wolfhart Pannenberg, *Anthropologie in Theologischer Perspektive* (Göttingen: Vandenhoeck & Ruprecht, 1983), ———, *Was Ist Der Mensch? Die Anthropologie Der Gegenwart Im Lichte Der Theologie*, 7 ed. (Göttingen: Vandenhoeck & Ruprecht, 1962).

[4] Barnard, *History and Theory in Anthropology*, 2-3.

[5] Two classics in anthropology that greatly influenced the development of cultural history are Clifford Geertz, *The Interpretation of Cultures: Selected Essays* (New York: Basic Books, 1973), ———, *Local Knowledge: Further Essays in Interpretive Anthropology* (New York: Basic Books, 1983).

[6] For an explanation of the differences, see Christoph Wulf, "Grundzüge Und Perspektiven Historischer Anthropologie. Philosophie, Geschichte, Kultur", in *Historische Anthropologie: Basis Texten*, ed. Aloys Winterling (Stuttgart: Franz Steiner Verlag, 2006).

[7] Keith Thomas, "History and Anthropology", *Past & Present* 24 (1963), Geertz, *Interpretation of Cultures*, ———, *Local Knowledge*, E. E. Evans-Pritchard, "Anthropology and History", in *Social Anthropology and Other Essays*, ed. E. E. Evans-Pritchard (New York: The Free Press, 1966). See also the collection of essays Aloys Winterling, ed. *Historische Anthropologie: Basis Texte* (Stuttgart: Franz Steiner Verlag,2006).and Homi K. Bhabha, *The Location of Culture* (London: Routledge, 1994). as well as the important journal *Anthropologie und Geschichte*, published by Böhlau Verlag. One fruitful result of exchanges between the disciplines was the extensive work on political culture and the French Revolution in the 1990s. See, for example, Roger Chartier, *The Cultural Origins of the French Revolution*

cultural anthropology's intellectual apparatus into a history of anthropology is more problematic than may be assumed. Cultural anthropologists disagree fiercely on their discipline's ancestors, highlighting everyone from the historian Herodotus, to the Natural Law theorist Hugo Grotius, the philosopher René Descartes, the writer Baron Montesquieu, the philosopher Immanuel Kant and the anthropologist Franz Boas as pioneers of the field.[8] They offer, thus, little guidance on matters chronological. More significant is that their search for ancestors is historical only in a narrow sense, as they seek an "anthropological moment", or the birth of *their* approach to the human being. This tactic is useful to contemporary anthropologists, because it justifies current practices and, thus, aids in keeping the discipline within reasonable boundaries.[9] Applied to historical issues, however, it is distortive and privileges only those trends of which modern scholars of anthropology are themselves direct products.

The literature on the birth of anthropology, whether written by anthropologists or historians influenced by them, has not confronted the present-mindedness of its question. In many cases scholars have simply projected the contemporary interest in culture backward in time; holding a mirror up to the past, they seek a familiar reflection. The point is not to argue that a history of anthropology must be written without the present in mind, but to demonstrate that only an interpretive structure independent of the anthropological canon can justify a chronological backstop on which all histories of anthropology, ultimately, rely. Otherwise, given human beings' inveterate propensity to talk about themselves, a history of anthropological thought can recede rapidly, as it has in one case, all the way to the Bible.[10]

Many prominent historical works on anthropology have used the discovery of cultural difference as their backstop. When scholars encounter someone who respected cultural difference (in a way of which they approve), there they plant anthropology's flag.[11] Contemporary anthropologists cannot, however, agree on a definition of culture, which limits the concept's

(Durham, NC: Duke University Press, 1991). For overviews, see Wolf Lepenies, "History and Anthropolgy. A Historical Appraisal of the Current Contact between the Disciplines", *Social Science Information* 15, no. 2/3 (1976), Hans Medick, "Quo Vadis Historische Anthropologie? Geschichtsforschung Zwischen Historischer Kulturwissenschaft Und Mikro-Historie", *Historische Anthropologie* 9, no. 1 (2001).

[8] On Herodotus, see Wilhelm E. Mühlmann, *Geschichte Der Anthropologie*, 2., verb. und erw. Aufl. ed. (Frankfurt am Main: Athenäum Verlag, 1968), Kluckhohn, *Anthropology and the Classics*. On Descartes, see Leaf, *Man, Mind, and Science*. On Grotius, Barnard, *History and Theory in Anthropology*. On Montesquieu, E. E. Evans-Pritchard, *Essays in Social Anthropology* (London,: Faber and Faber, 1962). On Immanuel Kant, Peter Skafte, "Kant's Legacy to Humanistic Anthropology", *Anthropology and Humanism Quarterly* 4, no. 1 (1979). The philosophical literature on Kant's anthropology is even more expansive. There is more on that literature below. On Boas, Douglas Cole, *Franz Boas: The Early Years, 1858-1906* (Vancouver: Douglas & McIntyre, 1999).

[9] George W. Stocking, "Delimiting Anthropology: Historical Reflections on the Boundaries of a Boundless Discipline", *Social Research* 62, no. 4 (1995).

[10] James S. Slotkin, *Readings in Early Anthropology* (Chicago: Aldine Publishing Company, 1965).

[11] See, for example, Mühlmann, *Anthropologie*, 15-21.

applicability across time.[12] And were historians to accept sensitivity to difference as a criterion, another problem obtains: scholars have identified at least three "anthropological moments". The first occurred in the Classical World in the work of Herodotus and Thucydides.[13] The second came in the sixteenth century, when Spanish voyagers to the New World, such as José de Acosta, wrote about the indigenous cultures they encountered.[14] The last came in the eighteenth century, when enlightened thinkers, such as the Baron Montesquieu, questioned the belief that European values were universal.[15] Widely dispersed in time and products of starkly different historical circumstances, it would be difficult to weave these disparate moments into a tradition, although this has been tried.[16]

Pursuing the history of anthropology via culture omits a variety of attitudes and assumptions that were fundamental to anthropology's construction of Man. The gendered term is used intentionally here, because European processes of knowledge production, in which anthropology is implicated, were also gendered.[17] As a result, gender's relationship to the birth of anthropology will be a recurring theme throughout this essay, although we will approach the issue only indirectly. Instead, we will put gender into a broader thematic context and begin with the supposition that anthropology developed in conjunction with deep changes in the Western way of knowing the world that occurred during the early-modern period.[18] From this perspective, the history of anthropology is part of the history of science, and science marks our point of departure.[19]

This essay argues that anthropology owes its origins to one particular scientific discipline, astronomy. It holds that anthropology is a product of the modern astronomy's emergence, which occurred between roughly 1400 and 1800 and that this new astronomy changed anthropology by developing and exporting sophisticated methods of projecting space. Astronomy's ability to dominate space created the environment in which Man was, ultimately, discovered.

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12 Clifford James, *The Predicament of Culture: Twentieth Century Ethnography, Literature, and Art* (Cambridge, MA: Harvard University Press, 1988), Joel Kahn, "Culture: Demise or Resurrection?", *Critique of Anthropology* 9, no. 2 (1989).

13 Mühlmann, *Anthropologie*.

14 Pagden, *The Fall of Natural Man*.

15 Evans-Pritchard, *History of Anthropological Thought*. Along similar lines, but with respect to the discovery of Eastern Europe, see Larry Wolff, *Inventing Eastern Europe: The Map of Civilization on the Mind of the Enlightenment* (Stanford, CA: Stanford University Press, 1994).

16 Mühlmann, *Anthropologie*.

17 Many of the issues dealt with implicitly here are covered explicitly in Londa L. Schiebinger, *The Mind Has No Sex?: Women in the Origins of Modern Science* (Cambridge, MA: Harvard University Press, 1989).

18 Pamela H. Smith and Benjamin Schmidt, eds., *Making Knowledge in Early Modern Europe: Practices, Objects, and Texts, 1400-1800* (Chicago: University of Chicago Press,2007).

19 Roger Smith, *The Norton History of the Human Sciences*, 1st American ed., Norton History of Science (New York: W. W. Norton & Company, 1997).

Anthropology's encounter with astronomy produced what we will call celestial anthropology. The two disciplines had largely parallel histories before the late seventeenth century, when they began to overlap. By the late eighteenth century, when early-modern astronomy reached it heights, anthropology had bought in completely, taking both its most important signposts and its method of organization from celestial science. The first soundings of full-blown celestial anthropology were heard around 1700 and ended around 1850, when the universe constructed by astronomers receded from anthropological discussion.

Celestial anthropology had two chief characteristics, spatiality and liminality. First, anthropologists learned from astronomers how to project space onto a planet that they could not see and a universe they could barely comprehend.[20] Second, once having learned to imagine natural spaces, including extraterrestrial ones, anthropologists filled all spaces with beings that were, in turn, shaped by them. The relative value of these beings was then determined by a cosmological agenda that organized the universe from the outside in, beginning with the farthest reaches of space and extending down to the planet Earth. This movement, from the margins of celestial space back to our planet, re-made anthropology's object of study: after 1700, Man became a cosmological construct.[21]

Part I

Against this backdrop, let us consider the epigram above. Taken from *Night Thoughts* (1742-45), a popular paean to the wonders of God's universe written by Edward Young (1681-1765), the epigram highlights the essence of celestial anthropology: human space on Earth is created by the mind's movement inward from the vastness that lies beyond. As Young put it, Man is purblind if he does not know the whole —which, for him, comprised the universe and the Earth that is suspended within it. The search for a whole is why he puts the viewer in orbit above our planet, because from there he can connect our terrestrial space with the realms of outer space. To steal a line from Nietzsche, the celestial anthropologist looks down.

Young represents well the convergence between early-modern astronomy and anthropology. The change was detectable already in the early seventeenth century and by the middle of the eighteenth, the two distinct but related streams of thought had become almost coterminous, with influences

[20] The anthropologist Victor Turner used liminality with reference social passage as managed by rituals. The sense of space used here is quite different and emphasizes how human beings imagined physical space. Victor Witter Turner, *The Ritual Process: Structure and Anti-Structure* (Ithaca, NY: Cornell University Press, 1977), 95, ———, "Betwixt and Between: The Liminal Period in Rites De Passage", in *Symposium on New Approaches to the Study of Religion*, ed. June Helm (Seattle: University of Washington Press, 1964).

[21] This argument is, hence, a gloss on the many important ones made in Hans Blumenberg, *The Genesis of the Copernican World*, trans. Robert M. Wallace (Cambridge, MA: MIT Press, 1987).

flowing in both directions. In 1747, for example, the astronomer and mathematician Abraham Gotthelf Kästner (1719-1800) put an anthropological spin on astronomy in an article he published in the *Hamburgisches Magazin* entitled, "In Praise of Astronomy", writing, "Do you want to know how far the powers of human understanding extend? Study astronomy!"[22] Meanwhile, the writer Johann Wolfgang Goethe (1748-1832) was equally convinced of astronomy's virtues, saying, "Astronomy is, for me, so valuable, because it is the only science of them all that rests on generally accepted, uncontested foundations, with which and in complete security [it] progresses ever further into infinity."[23] Goethe knew of what he spoke. The Duke of Weimar had put him in charge of the Jena Observatory and its library, which meant that he not only bought most of the observatory's books, but also read them, too.[24]

Astronomy's significance for anthropology lay in the conceptual tools that it developed for imagining space. Consider these words from *Cosmological Letters on the Arrangement of the World-Edifice* (1761), a popular scientific work published by the Alsatian mathematician and member of the *Berlin Academy of Sciences* Johann Heinrich Lambert (1728-1777):

> I have thereby stretched the imagination as far as the world-edifice reaches, and it is now no problem for me to take the distance of our sun from a fiftieth magnitude star as a yardstick, and, by laying it off a million times, to set it up as a measure against the limits of the system of those stars which we see with telescopes and of those which are still beyond.[25]

Lambert was not alone in teaching methods to project space onto the universe, as the educated elite across Europe produced a variety of pedagogical tools, including textbooks, journal articles, calendars and even globes. As a result, by the end of the century, a broad swath of Europe's intellectual elite had become conversant in the basics of astronomy, often applying the newest astronomical ideas to their understanding of the human being. Edward Young, for his part, used this eighteenth-century spatial turn to transform humans almost into gods:

> How glorious, then, appears the mind of man,
> When in it all the stars, and planets, roll!
> And what it seems, it is: great objects make
> Great minds, enlarging as their views enlarge;

[22] Abraham G. Kästner, "Das Lob Der Sternkunst", *Hamburgisches Magazin, oder gesammlete Schriften, zum Unterricht und Vergnügen* 1, no. 2 (1747).
[23] Quoted in, Aeka Ishihara, "Goethe Und Die Astronomie Seiner Zeit. Eine Astronomisch-Literarische Landschaft Um Goethe", *Goethe-Jahrbuch*, no. 117 (2000): 115.
[24] *Ibid*, Stanley L. Jaki, "Goethe and the Physicists", *American Journal of Physics* 37, no. 2 (1969).
[25] Johann Heinrich Lambert, *Cosmological Letters on the Arrangement of the World-Edifice*, trans. Stanley L. Jaki, 1st ed. (New York: Science History Publications, 1976).

> Those still more godlike, as these more divine.[26]

Young's position was extreme, but like Kästner's, it exalted the human being with reference to outer space.

The exaltation of Man via outer space was also a central theme for Alexander Pope (1688-1744) in his anthropological work "Essay on Man" (1733-1734), which was widely read and translated. Divided into three Epistles, the work mirrors much of the celestial anthropological literature, in that it moves expressly from the outside in. Consider the subtitle of the first epistle, "Of the Nature and State of Man with Respect to the Universe", wherein Pope writes:[27]

> He, who through vast immensity can pierce,
> See worlds on worlds compose one universe,
> Observe how system into system runs,
> What other planets circle other suns,
> What varied peoples circle every star,
> May tell us why Heaven has made us as we are.

Thereon follow two epistles entitled, "Of the Nature and State of Man with Respect to Himself as an Individual", and "Of the Nature and State of Man with Respect to Society."[28] Pope reveals how, by the eighteenth century, anthropology's boundaries had changed: Man came after reference to the stars.

For his part, Pope injected a note of humility into celestial anthropology. He was not alone, as others pursued restrained lines. Lord Bolingbroke thought that, in the face of the universe's massive size, it would be stupid to believe that humans were foremost among created beings, let alone to give any special significance to our planet.[29] And in 1726, the English Dissenter and hymnalist Isaac Watts pursued his own, modest line, writing:

> You can tell the world, that it is the knowledge of this globe of Earth on which we tread, and of those heavenly bodies which seem to roll around us, that hath been wrought up into these two kindred sciences, geography and astronomy.[30]

And it is thanks to these sciences that we learn, "This Earth is given us for an

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[26] Young, *Night Thoughts*.
[27] Alexander Pope, *Essay on Man and Other Poems* (New York: Dover Publications, 1994), 45.
[28] *Ibid*., 53,60.
[29] Lord Bolingbroke, *The Works of the Late Right Honorable Henry St. John, Lord Viscount Bolingbroke*, 8 vols., vol. 8 (London: J. Johnson, *et al*., 1809), 173.
[30] Isaac Watts, *The First Principles of Astronomy and Geography Explain'd by the Use of Globes and Maps: With a Solution of the Common Problems by a Plain Scale and Compasses, as Well as by the Globe* (London: J. Clark and R. Hett, 1726), vi.

habitation: it is the place of present residence for all our fellow mortals."[31] Regardless of the tone, celestial anthropology created the spatial superstructure in which humanity became a fully terrestrial phenomenon. Humans belonged *here*, with the *here* being defined against what was *out there*.

Now, let us consider one of the most famous and least explicated anthropological outbursts of the eighteenth century. Coming in the conclusion to Immanuel Kant's second great critique, *Critique of Practical Reason* (1787), it notes:

> Two things fill the mind with ever new and increasing admiration and awe, the more often and steadily reflection is occupied with them: the starry heaven above me and the moral law within me. Neither of them need I seek and merely suspect as if shrouded in obscurity or rapture beyond my own horizon; I see them before me and connect them immediately with my existence.[32]

By the late eighteenth century, astronomical themes served as the ultimate backdrop to anthropological thought. Although Kant's humans have their feet planted on earthly soil, their sense of self emerges via their contemplation of the Heavens. It is, thus, no accident that in the introduction to his first critique, *Critique of Pure Reason* (1781) Kant judged the historical significance of his philosophy with reference to Copernicus, the founder of the modern heliocentric universe.[33] At the core of enlightened thought, which Kant most certainly represents, thinking astronomically went hand-in-hand with thinking anthropologically.[34]

Part II

Amidst the anthropological literature's breadth and richness there is hardly any mention of astronomy as a source for anthropology, whether classical, medieval, early-modern, or modern.[35] Knowledge of outer space has, however, long played an important role in Western intellectual history, as the human being has continually been defined with reference to the regnant

[31] *Ibid.*

[32] Johann Gottfried Herder, "Newton Und Keppler", *Adrastea* 3 (1802), ———, "Newtons Theorie Des Lichts Und Der Farben", *Adrastea* 3 (1802), ———, "Isaak Newtons Gesetz Der Schwere", *Adrastea* 3 (1802), Zammito, *Kant, Herder, and the Birth of Anthropology*, Johann Gottfried Herder, "Newtons Teleskop", *Adrastea* 3 (1802).

[33] Immanuel Kant, *Immanuel Kant Werkausgabe*, ed. Wilhelm Weischedel, 12 vols., vol. I (Frankfurt am Main: Suhrkamp Verlag, 1974), 25.

[34] On astronomy in the eighteenth-century, see Rainer Baasner, *Das Lob Der Sternkunst: Astronomie in Der Deutschen Aufklärung* (Göttingen: Vandenhoeck & Ruprecht, 1987).

[35] An exception is Karl Guthke, *The Last Frontier: Imagining Other Worlds, from the Copernican Revolution to Modern Science Fiction*, trans. Helen Atkins (Ithaca and London: Cornell University Press, 1990). This text is essential reading for anyone interested in the celestial aspects of anthropology.

cosmology.[36] (We will set aside the question of how theology interacted with anthropology and cosmology, although the interrelationship is long-standing and of great significance to the development of European thought.) The Gnostics of the classical and early Christian era saw the universe as a hostile place that existed only to fool human beings. They took a dim view of humanity. Other cosmologies, such as the geocentric Aristotelian-Ptolemaic system of the medieval theologian St. Thomas Aquinas (1225-1274), or the heliocentric system of the Renaissance astronomer Nicolaus Copernicus (1473-1543), yielded more optimistic visions of the human condition. Historically (and loosely) speaking, when astronomers altered the cosmology, anthropologists took note.

The heavens have been above us for a long time, so astronomy's history dates back at least as far as the human beings' profound interest in themselves.[37] Although the relationship between the two disciplines understood broadly is long, celestial anthropology owes its origins to the development of a specifically modern astronomy. Modern astronomy began, in fifteenth century Europe, within the humanist circles of Renaissance Italy.[38] It had three chief characteristics: the critical reception of classical spatial thought, the renewed emphasis on direct observation of the heavens, and the development of communication networks among observers. The first trend ended by the middle of the sixteenth century. The latter two, however, extended through the end of the eighteenth century and reach even into our own day.

Although Renaissance astronomy had important precursors in both the Medieval Christian and Islamic traditions, a quickening began around the turn of the fourteenth century, with the importation into Italy of classical texts from Constantinople, which was menaced by Ottoman forces.[39] Unlike the

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[36] On cosmology in general, see Helge S. Kragh, *Conceptions of Cosmos: From Myths to the Accelerating Universe: A History of Cosmology* (New York: Oxford University Press, 2007). On the early Christians and the universe, see J. Edward Wright, *The Early History of Heaven* (New York: Oxford University Press, 2000). On the Gnostics, see Hans Jonas, *The Gnostic Religion: The Message of the Alien God and the Beginnings of Christianity* (Boston: Beacon Press, 2001). On Medieval and Renaissance cosmology, see Ernst Cassirer, *The Individual and the Cosmos in Renaissance Philosophy*, trans. Mario Domandi (Mineola, N.Y.: Dover Publications, 2000), Edward Grant, *Planets, Stars, and Orbs: The Medieval Cosmos, 1200-1687* (Cambridge Cambridge University Press, 1996), Pierre Maurice Marie Duhem, *Medieval Cosmology: Theories of Infinity, Place, Time, Void, and the Plurality of Worlds* (Chicago: University of Chicago Press, 1985), Alexandre Koyré, *From the Closed World to the Infinite Universe* (New York: Harper & Brothers, 1957), Edward Grant, "The Medieval Cosmos: Its Structure and Operation", *Journal for the History of Astronomy* 28 (1997). On Copernicus and cosmology, see Blumenberg, *Genesis*, Henry Guerlac, "Copernicus and Aristotle's Cosmos", *Journal of the History of Ideas* 29, no. 1 (1968).

[37] For a definitive overview of the history of astronomy and the cosmological thought that has emerged from it, see John D. North, *Cosmos: An Illustrated History of Astronomy and Cosmology* (Chicago, IL: University of Chicago Press, 2008).

[38] Michael A. Hoskin, ed. *The Cambridge Concise History of Astronomy* (Cambridge: Cambridge University Press,1999). This text makes the case that astronomy dates back at least to the ancient Babylonians. See also Anton Pannekoek, *A History of Astronomy* (New York: Interscience Publishers, Inc, 1961).

[39] Stephen C. McCluskey, *Astronomies and Cultures in Early Medieval Europe* (Cambridge: Cambridge University Press, 1998), Duhem, *Medieval Cosmology*, Pannekoek, *A History of Astronomy*, Michael Hoskin, ed. *The Cambridge Concise History of Astronomy* (Cambridge: Cambridge University Press,1999), Grant, *Planets, Stars, and Orbs: The Medieval*

twelfth-century transmission of classical works to Europe, which had been piecemeal and went via Arabic, before entering into Latin, these texts had never been translated out of the original Greek.[40] Their ostensible purity and sheer mass piqued the interest of European scholars, who compared the new translations with older versions, noting both minor differences and outright errors. At this time, many important works returned, including Euclid's *Elements* and Archimedes' *On the Sphere and the Cylinder*. (The history of geometry's return to early-modern Europe is of great significance to both astronomy and anthropology. Euclid will be present on the margins of this essay, but the significance of his work cannot be covered fully here.) With regard to astronomy, the most important texts were Claudius Ptolemy's *Almagest*, which propounded a geocentric cosmology, and his *Geographia*, which summarized the geographic knowledge of the ancient world.[41] These two texts are the conceptual foundation of a spatial aesthetic within which Man became possible.

The Classical corpus' migration from Byzantium did not make outer space a terrestrial issue by itself. Instead, the arrival of texts from the East coincided felicitously with the termination of a fierce debate within the late medieval world about the regnant cosmology's conception of extra-terrestrial space. A product of Aristotle and Ptolemy's twelfth-century importation into Europe, the system combined the physics of the former with cosmology of the latter. Following Aristotle, it infused physics with teleology and ascribed to every physical structure or phenomenon a specific purpose. Following Ptolemy, it embedded the planets and stars in a series of concentric, crystalline spheres that rotated diurnally about an Earth positioned at the center.[42] The unification of teleology with physics and cosmology was attractive to medieval thinkers, especially St. Thomas Aquinas, because it eased the incorporation of a Christian Creator into the Classical world's rich scientific heritage, and the result was a dense, compact cosmology that explained almost every aspect of the universe, including Man's central position within it.[43]

The Aristotelian-Ptolemaic system had two major weaknesses. First, the system of crystalline spheres did not accurately predict planetary

Cosmos, 1200-1687 , Lynn Thorndike, *The Sphere of Sacrobosco and Its Commentators* (Chicago: The University of Chicago Press, 1949). On Copernicus and medieval Islamic astronomy, see F. Jamil Ragep, "Tusi and Copernicus: The Earth's Motion in Context", *Science in Context* 14, no. 1/2 (2001).

40 On the early reception of Greek texts in medieval Europe, see Marcia L. Colish, *Medieval Foundations of the Western Intellectual Tradition, 400-1400*, Yale Intellectual History of the West (New Haven, CT: Yale University Press, 1997), R. R. Bolgar, *The Classical Heritage and Its Beneficiaries* (Cambridge: Cambridge University Press, 1963).

41 Brian P. Copenhaver and Charles B. Schmitt, *Renaissance Philosophy*, A History of Western Philosophy (Oxford; New York: Oxford University Press, 1992), Charles B. Schmitt, Quentin Skinner, and Eckhard Kessler, *The Cambridge History of Renaissance Philosophy* (Cambridge; New York: Cambridge University Press, 1988), John M. Headley, "Geography and Empire in the Late Renaissance. Botero's Assignment, Western Universalism and the Civilizing Process", *Renaissance Quarterly* 53, no. 4 (2000).

42 McCluskey, *Astronomies and Cultures.*

43 Grant, *Planets, Stars, and Orbs: The Medieval Cosmos, 1200-1687.*

movements.[44] As the new texts rolled in, people interested in astronomy tested the information contained therein against older versions and new observations. Some observers noted, for instance, that even in its purest form, Ptolemy's *AImagest* left out a host of stars in its charts that were visible to astronomers, which only opened the door to further investigation. Second, this system assumed a qualitative difference between terrestrial and extra-terrestrial space. In the medieval world space was inherently fractured and limited, an attitude that had broad effects in the intellectual realm.[45] From the perspective of the history of science, fractured space precluded the pursuit of a universal system of physics, since the rules that obtained in the terrestrial sphere did not extend to rarified realms. And with respect to the history of anthropology, this arrangement prevented the terrestrialization of the human being that we have seen above in Young's *Night Thoughts*.

The modern Newtonian system under which we (mostly) live addressed both weaknesses, so we tend not to understand them separately. The overcoming of the first is part of the standard narrative of the Scientific Revolution, in which a succession of luminaries —Copernicus, Johannes Kepler (1571-1630), Galileo Galilei (1564-1642) and Isaac Newton (1643-1727)— broke with Ptolemy's geocentrism, because it could not explain the observed phenomena.[46] The latter weakness was, however, important to the birth of anthropology, because in testing the limits of Aristotle's physics, human beings learned to construct and project their minds into realms that they could not experience. For example, in the fourteenth century, speculative debates arose on whether the rules that governed terrestrial space would also hold in rarified realms, such as one that concerned whether angels, who lived in the highest realms, could speak to each other in the absence of an atmosphere that carried their voices.[47] There was no clear answer to the question, but the constant speculative testing of boundaries weakened the hierarchical conception of space that had been inherited from the twelfth century and suggested that reason could perch itself in physical spaces beyond our planet.[48]

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[44] Hoskin, ed. *History of Astronomy*. Even geocentrists, such as Christoph Clavius were hardly uncritical of the Ptolemaic system. James M. Lattis, *Between Copernicus and Galileo: Christoph Clavius and the Collapse of Ptolemaic Cosmology* (Chicago: University of Chicago Press), 106-125.

[45] David Woodward, "Reality, Symbolism, Time, and Space in Medieval World Maps", *Annals of the Association of American Geographers* 75, no. 4 (1985).

[46] Some examples: A. Rupert Hall, *From Galileo to Newton* (New York: Dover Publications, 1981), René Taton and Curtis Wilson, *Planetary Astronomy from the Renaissance to the Rise of Astrophysics, Part A: Tycho Brahe to Newton*, ed. Michael Hoskin, The General History of Astronomy (Cambridge: Cambridge University Press, 1989). This view of the scientific revolution was constructed in the eighteenth century. See Margaret C. Jacob, "The Truth of Newton's Science and the Truth of Science's History: Heroic Science at Its Eighteenth-Century Formulation", in *Rethinking the Scientific Revolution*, ed. Margaret J. Osler (Cambridge: Cambridge University Press).

[47] W. G. L. Randles, *The Unmaking of the Medieval Christian Cosmos, 1500-1700: From Solid Heavens to Boundless Aether* (Aldershot: Ashgate, 1999).

[48] Amos Funkenstein, *Theology and the Scientific Imagination from the Middle Ages to the Seventeenth Century* (Princeton, NJ: Princeton University Press, 1986).

The rise of stellar observation was sparked by discrepancies between and among copies of classical texts. This trend was, however, insufficient to extend the discipline across Europe. For that to happen astronomers needed places to do astronomy. Here, the extension of the European university system in the late Middle Ages was important, as universities were founded in Cracow (1364), Heidelberg (1386), Pisa (1343), Prague (1348) and Vienna (1380). These institutions served as alternative centers of inquiry outside the traditional centers of Oxford, Paris and Bologna (all 11th Century). Many provided institutional support for astronomy and became places where the traditional Aristotelian-Ptolemaic cosmology was reviewed. The multiplication of spaces for astronomy continued through the succeeding two centuries, with the founding of many additional universities, such as those in Tübingen (1480) and Wittenberg (1502), and this trend extended well into the eighteenth century. The new universities often hosted the latest astronomical thought. As a result, astronomy very slowly became a continental science. By the sixteenth century, some of the most important astronomical work in Europe was being done in Bohemia, Germany and Poland.

The astronomer Johannes Müller, aka Regiomontanus (1436-1476) exemplifies the transformation of Renaissance astronomy.[49] Born in Bavaria, he attended the University of Vienna and studied under the Ptolemaic astronomer Georg Peurbach (1423-1461). He then went to Rome, which had become of center of translation, with the arrival from Constantinople of Cardinal Basilios Bessarion (1403-1472), who brought with him a massive collection of manuscripts. There, Müller translated parts of a Greek version of the *Almagest*, producing in 1462 a Latin epitome that, for over a century, remained widely read.[50] After returning to Germany, Müller went to Nuremberg, a prosperous manufacturing town whose central location and craft traditions made it ideal for practicing astronomy.[51] Here, in 1471, he built an observatory and, in 1474, published under the title *Theoricae novae planetarum* ("New Theory of the Planets") an astronomical text written by Peurbach.[52] A geocentric work, the *Theoricae* was the first astronomical textbook published in Europe since classical times. It influenced many astronomers, including the father of modern heliocentrism, Nicolaus Copernicus.[53]

Beginning in the middle of the fifteenth century, as more astronomers and observatories appeared, astronomy burrowed deeply into the consciousness of

[49] W. P. D. Wightman, *Science and the Renaissance*, 2 vols., Aberdeen University Studies (Edinburgh: Oliver and Boyd, 1962).
[50] *Ibid*., 13-15.
[51] *Ibid*., 22-24.
[52] A. Rupert Hall, *The Scientific Revolution, 1500-1800: The Formation of the Modern Scientific Attitude* (London: Longman, 1962), 57.
[53] *Ibid.*

early-modern Europe.[54] Some of the growth in astronomical activity was associated with princely interest in occult sciences, such as astrology.[55] Some was due to the need to organize the expanding pool of geographical knowledge that was collected during what one historian has called the Age of Reconnaissance.[56] And some was due to the need to reform the Julian calendar, which had gotten badly out of step with the seasons.[57] (The Popes supported this latter project and, in 1582, it yielded the Gregorian calendar, which is the foundation of our own).[58] Overall, as a result of these factors, by the end of the sixteenth century Europe was covered by a network of observatories, in which sat ensconced astronomers who observed the heavens, read the classics, and, most importantly, published and read new works.[59]

The trends that impelled the new astronomy came together in Nicholas Copernicus. In 1491, Copernicus matriculated in Cracow at what would become the Jagiellonian University, though without taking a degree. Later, he headed to Italy, where he studied in Bologna, Rome and Padua (the latter having been founded in 1222 as a rebellion against Bologna) before settling in Frombork, Poland, where he maintained an observatory with church funds. Two significant works emerged, the *Commentariolus* ("Little Commentary") (1514), which was a précis to his heliocentric theory and only distributed in manuscript, and the epochal *De revolutionibus orbium coelestium* ("On the Revolutions of the Heavenly Spheres") (1543), which was published as a book and argued for a heliocentric universe.

Copernicus's work was widely read and admired, although not always accepted.[60] Significantly, however, Copernicus was universally recognized as a great geometer, which meant that even if his cosmological conclusions were ignored, his practice of applying geometrical analyses to the heavens diffused widely. Generally, historians of science have celebrated *De revolutionibus* as a great advance in the project of creating an ever more accurate picture of the universe. This it was. To take this position exclusively limits, however, the

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54 Nicholas Jardine, "The Places of Astronomy in Early-Modern Culture", *Journal for the History of Astronomy* 29 (1998), Robert S. Westman, "The Astronomer's Role", *History of Science* 18, no. 40 (1980). It is worthwhile to compare the changing notion of the astronomer's role in early-modern Europe with the medieval traditions of astronomy outlined in McCluskey, *Astronomies and Cultures* The insights on universities are an extension of the arguments made in Joseph Ben-David, "Scientific Productivity and Academic Organization in Nineteenth-Century Medicine", *American Sociological Review* 25, no. 6 (1960).

55 Lloyd Motz and Jefferson Hane Weaver, *The Story of Astronomy* (New York: Plenum Press, 1995), 10-11, Copenhaver and Schmitt, *Renaissance Philosophy*, 76, 159, Hans Ludendorff, "Zur Frühgeschichte Der Astronomie in Berlin", *Preussische Akademie der Wissenschaften: Vorträge und Schriften*, no. 9 (1942).

56 John H. Parry, *The Age of Reconnaissance: Discovery, Exploration and Settlement 1450 to 1650* (Berkeley, CA: University of California Press, 1981).

57 The Julian calendar was too short, which resulted in its migration forward through the seasons.

58 Anthony F. Aveni, *Empires of Time: Calendars, Clocks, and Cultures* (New York: Basic Books, Inc., 1989). See also McCluskey, *Astronomies and Cultures* , Lattis, *Between Copernicus and Galileo*.

59 Jardine, "The Places of Astronomy.", Westman, "The Astronomer's Role."

60 Owen Gingerich, *The Book Nobody Read: Chasing the Revolutions of Nicolaus Copernicus* (New York: Walker & Company, 2004), Robert S. Westman, *The Copernican Achievement*, vol. 7, Contributions of the Ucla Center for Medieval and Renaissance Studies (Berkeley: University of California Press, 1975).

significance of Copernicus' great work.

For the purposes of this essay, *De revolutionibus* marks the moment when a new spatial structure crystallized that would, in turn, incubate the modern celestial anthropology.[61] Copernicus legitimized a spatial perspective that was free both of the Earth and the teleological web in which it had been implicated by the medieval system. Consider his classic drawing of the heliocentric universe. (See Figure 1.) First, the system is predicated on the construction of a position from which someone could look down on our solar system. This aspect of Copernicanism was a reinterpretation of both Medieval and Renaissance traditions, both of which had acquired various tools for spatial thought from the Muslim world.[62] People could, no doubt, think spatially before Copernicus, and the Renaissance spatial imagination continued to take into account medieval texts on geometric space, such as *De sphere* ("On the Spheres") by John of Holywood (1195-1256).[63] Nonetheless, by putting the sun at the center of his system Copernicus made space an anthropological issue, as heliocentrism transformed the Earth from the universe's focal point into merely one sphere among seven (the Sun plus six planets), each of which, because of their status *as spheres*, could now be imagined as places for life.[64] In this sense, geometric thought redefined the space for life.[65]

The significance of spatial thought to anthropology is apparent in the organization of *De revolutionibus*. The text comprises six books, the first two of which deal expressly with geometric topics and explain how the universe, the Earth and all the planets and stars are spheres. As an early example of the anthropological tendencies that were latent in thinking from the outside in, consider the titles of the first three chapters of the book. The first is entitled, "That the universe is a sphere", and the second, "That the Earth is a sphere, too", and the third, "How the Earth together with water makes up one globe."[66] This conceptual progression serves as the bedrock for the cosmological agenda that anthropology imported from astronomy, as Copernicus' move, within the space of two pages, from the celestial to the global to the Earth's surface used the concept of a spatial whole in a way that licensed, among other things, Edward Young's exuberance.

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61 On this point, see Blumenberg, *Genesis*, Miguel A. Granada, "Aristotle, Copernicus, Bruno: Centrality, the Principle of Movement and the Extension of the Universe", *Studies in the History and Philosophy of Science* 35 (2004).

62 Alfred W. Crosby, *The Measure of Reality: Quantification and Western Society, 1250-1600*, 1st pbk. ed. (Cambridge: Cambridge University Press, 1998).

63 Thorndike, *The Sphere of Sacrobosco*.

64 Blumenberg, *Genesis*.

65 On the meaning of the shift in the universe's center, see *Ibid*, Granada, "Aristotle, Copernicus, Bruno." On extraterrestrial life in unexpected places, Robert J. Manning, "John Elliot and the Inhabited Sun", *Annals of Science* 50 (1993).

66 Nicolaus Copernicus, *De Revolutionibus Orbium Coelestium* (Norimbergae: apud Ioh. Petreium, 1543), 8-9. The latter insight on the nature of the terrestrial globe becomes the starting point for many geographic texts up through the eighteenth century. See, for example, John Mair, *A Brief Survey of the Terraqueous Globe* (Edinburgh: Kincaid & Bell, 1762).

Copernicus was greatly impressed with geometric ways of understanding the whole. He wrote, for instance, "The first point for us to note is that the universe is spherical, whether because the form itself belongs to everything, is an integral whole, needing no joints; or because this figure is the one that has the greatest volume and is, thus, especially suitable for comprehending and conserving all things."[67] The sphere is the perfect form, and this geometric construction of a whole was imported into early-modern anthropology up through the end of the eighteenth century. We have already mentioned Young, for whom the whole was a central concept. In addition, consider that, in 1781, the German naturalist Georg Forster (1754-1794) wrote a short text entitled, "A Glimpse into the Whole that is Nature", in which he organized the growth in natural knowledge according to the sequential emergence of key disciplines, beginning with physics (the study of how the heavens go), before adding physiology and chemistry. Forster's work is one example of the approach that the Copernican spatial plan recommended, as the knowledge of the universe preceded all forms of inquiry.[68]

At this point, we must note that Copernicanism was part of a broader early-modern discussion of outer space. Even if not everyone immediately accepted Copernicus's heliocentric doctrine, Europe's astronomical tradition had become so widespread and rich that extra-terrestrial space inevitably became a prominent theme on Earth, among Copernicans and non-Copernicans alike. For example, during the sixteenth century, a number of centers of observation outside universities appeared. The German court city of Kassel became a center of research under Prince William IV of Hesse-Kassel (1532-1592), a Copernican who maintained an observatory was in frequent contact with other astronomers, including the Dane Tycho Brahe (1546-1601).[69] Brahe, who was not a Copernican, set up an observatory in Denmark, from whence he published works that all types of astronomers read, while also corresponding with astronomers such as Johannes Kepler (1571-1630).[70] Kepler, a Copernican, studied at the University of Tübingen, which had hosted a chair in astronomy since 1511 and was a center of Copernican thought.[71] Later, he worked closely in Prague with Brahe and under the sponsorship of the Holy Roman Emperor, Rudolf II (1552-1612), who had a taste for

[67] Copernicus, *De Revolutionibus*, 8.

[68] Georg Forster, "Ein Blick in Das Ganze Der Natur", in *Georg Forster's Sämmtliche Schriften*, ed. Georg Gottfried Gervinus (Leipzig: F.A. Brockhaus, 1843), 308-09.

[69] Bruce T. Moran, "Christoph Rothmann, the Copernican Theory, and Institutional and Technical Influences on the Criticism of Aristotelian Cosmology", *Sixteenth-Century Journal* 13, no. 3 (1982), Randles, *The Unmaking*.

[70] Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe* (Cambridge: Cambridge University Press, 1990), Adam Mosley, *Bearing the Heavens: Tycho Brahe and the Astronomical Community of the Late Sixteenth Century* (Cambridge: Cambridge University Press, 2007).

[71] Charlotte Methuen, "Maestlin's Teaching of Copernicus: The Evidence of His University Textbook and Disputations", *Isis*, no. 87 (1996).

astrology.[72] Many of the same themes appear in the life of Galileo Galilei, who studied and taught at the University of Pisa, before moving to Padua, where he published the epochal *The Starry Messenger* (1610), which reported his findings from the first use of a telescope.[73] With access to the telescope, people could now see the spaces they had, to that point, only been imagining.

By the seventeenth century, the continental-wide process of observation, calculation, and publication had become so vast that astronomy was, in effect, a public science.[74] Early-modern astronomy reached its height, however, in the foundation of permanent, professional observatories. The three most important were in Paris (1671), Greenwich (1675) and Berlin (1710).[75] Each of these observatories worked closely with an academy of science: the *Académie des Sciences* (1666) in Paris, the *Royal Society* (1660) in London and the *Berlin Academy* (1701).[76] This alliance shifted the astronomical discipline's center of gravity away from universities and courts and toward increasingly professional academies. These entities then took the information provided by astronomers and published a wide variety of astronomical media, including star charts, calendars and other pedagogical works, all of which further diffused the astronomy's sense of space.[77]

Print diffusion made astronomy as much a collective process as one of solitary investigation. For example, Isaac Newton could not have completed the *Principia mathematica* (1687), *the* epochal work in the history of science, without the grudging cooperation of the astronomer royal John Flamsteed.[78] The *Principia* cemented the Copernican universe with its explanation of all planetary motion, the Earth included, under the theory of universal gravity. In doing so, it cemented the heliocentric perspective and licensed ever-greater

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72 Max Caspar, Kepler, trans. Clarisse Doris Hellman (New York: Dover Publications, 1993), Kitty Ferguson, *Tycho & Kepler: The Unlikely Partnership That Forever Changed Our Understanding of the Heavens* (New York: Walker & Company, 2002).

73 Stillman Drake, *Galileo at Work: His Scientific Biography* (Chicago: University of Chicago Press, 1978), ———, *Galileo: A Very Short Introduction* (Oxford: Oxford University Press, 2001). On Galileo's ties to early-modern courts, see Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism*, Science and Its Conceptual Foundations (Chicago: University of Chicago Press, 1993).

74 Jan V. Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760-1820* (Cambridge: Cambridge University Press, 1992).

75 Derek Howse, ed. *The Greenwich List of Observatories: A World List of Astronomical Observatories, Instruments and Clocks, 1670-1850* (Science History Publications,1986).

76 Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803* (Berkeley, CA: University of California Press, 1971), Adolf von Harnack, *Geschichte Der Königlich Preussischen Akademie Der Wissenschaften Zu Berlin* (Berlin: Reichsdruckerei, 1900). More generally, see Ludwig Hammermayer, "Akademiebewegung Und Wissenschaftsorganisation Während Der Zweiten Hälfte Des 18. Jahrhunderts", in *Wissenschaftspolitik in Mittel- Und Osteuropa*, ed. E. Amburger (Berlin: 1976), Fritz Hartmann and Rudolf Vierhaus, *Der Akademiegedanke Im 17. Und 18. Jahrhundert : Vorträge Gehalten Anlässlich Des 2. Wolfenbütteler Symposions Vom 9. Bis 12. Dezember 1975 in Der Herzog August Bibliothek* (Bremen: Jacobi Verlag, 1977).

77 Johann Elert Bode (1747-1826), a director of the observatory in Berlin, published a variety of pedagogical works, commentaries in journals, as well as star charts. See Johann Elert Bode, *Anleitung Zur Kenntniß Des Gestirnten Himmels Auf Jede Einzelne Monate Des Jahres Eingerichtet* (Hamburg: Harmsen, 1768).

78 Simon Schaffer, "Newton on the Beach: The Information Order of *Principia Mathematica*", *History of Science* xlvii (2009).

speculation about life in the universe. The *Principia* is, therefore, part of the history of physics, the history of astronomy *and* the history anthropology, as it became the focus of a broad effort at popularization, which included works by noted eighteenth-century anthropologists, such as Voltaire (1694-1778) who published *Elements of the Philosophy of Newton* (1738) and Immanuel Kant (1724-1804) who published the Newtonian work *General Natural History and Theory of the Heavens* (1755).[79] Thanks to the many popularizers that became involved, astronomical space became a pervasive presence in European thought and its effects reverberated well into the nineteenth century. For example, in 1801, Georg Wilhelm Friedrich Hegel, the most important philosopher of that era, published his obligatory second dissertation, the *Habilitationsschrift*, under the title *Dissertatio philosophica de orbitis planetarum* ("Philosophical Dissertation on the Orbits of the Planets").[80] Five years later, Hegel changed the course of European philosophy with the publication of *Phenomenology of Spirit*.[81] Before that moment came, however, he confronted astronomy, because knowledge of the heavens had become the bedrock on which Europe's intellectual edifice rested.[82]

Part III

Although scholars of anthropology have overlooked extra-terrestrial space, geographic space has long been integral to their analyses.[83] Regardless of the chronologies to which they adhere, scholars of anthropology agree that the discipline emerged from the European mind's projection around the globe, to places where the people looked and acted differently from a perceived norm.[84] As the anthropologist Wilhelm Mühlmann wrote:

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79 Voltaire, *Elémens De La Philosophie De Neuton: Mis À La Portée De Tout Le Monde* (Amsterdam: Desbordes, 1738), Immanuel Kant, *Allgemeine Naturgeschichte Und Theorie Des Himmels: Oder Versuch Von Der Verfassung Und Dem Mechanischen Ursprunge Des Ganzen Weltgebäudes Nach Newtonischen Grundsätzen Abgehandelt* (Königsberg: Petersen, 1755). See also Francesco Algarotti, *Il Newtonianismo Per Le Dame, Ovvero Dialoghi Sopra La Luce E I Colori* (Naples: s.n., 1739). Important contemporary works on the issue: James A. Secord, "Newton in the Nursery: Tom Telescope and the Philosophy of Tops and Balls, 1761-1838", *History of Science* 23 (1985), Massimo Mazzotti, "Newton for Ladies: Gentility, Gender and Radical Culture", *British Journal for the History of Science* 32, no. 2 (2004).

80 G. W. F. Hegel, "Disseratio Philosophica De Orbitis Planetarum" (Habilitation, University of Jena, 1801), Olivier Depré, "The Ontological Foundations of Hegel's Dissertation of 1801", in *Hegel and the Philosophy of Nature*, ed. Stephen Houlgate (Albany, NY: State University of New York Press, 1998).

81 Georg Wilhelm Friedrich Hegel, *Phenomenology of Spirit*, trans. Arnold V. Miller and J. N. Findlay (Oxford: Oxford University Press, 1977).

82 For the most part, historians of science have concentrated on the reception of Newtonianism. This essay adds a spatial dimension. Betty Jo Teeter Dobbs and Margaret C. Jacob, *Newton and the Culture of Newtonianism* (Atlantic Highlands, N.J.: Humanities Press, 1995). On Hegel and astronomy, see Blumenberg, *Genesis*.

83 An example: Eberhard Berg, *Zwischen Den Welten: Über Die Anthropologie Der Aufklärung Und Ihr Verhältnis Zu Entdeckungs-Reise Und Welt-Erfahrung Mit Besonderem Blick Auf Das Werk Georg Forster*, Beiträge Zur Kulturanthropologie (Berlin: Reimer, 1982).

84 Paul Hazard makes this point very briefly in his classic *The European Mind*. Wolff, *Inventing Eastern Europe*. See also Mühlmann, *Anthropologie*, Werner Krauss, *Zur Anthropologie Des 18. Jahrhunderts: Die Frühgeschichte Der Menschheit Im*

> The discipline of anthropology emerged from curiosity about foreign and distant lands and their different peoples. This inquisitiveness about the exotic kindled questions about the origin of the human species, the genesis and beginnings of human culture, language, society and religion, as well as the division of humanity into races and peoples, and their [respective] development…[85]

Mühlmann's position is an offshoot of two venerable traditions. The first runs from Jakob Burckhardt, in the late nineteenth century, up through Wilhelm Dilthey, in the early twentieth and beyond.[86] It emphasizes the trends in the Renaissance and Baroque Europe that led to the elaboration of the human subject, with the most important period demarcated, at one end, by René Descartes (1596-1650) and his construction of the philosophical subject in *Discourse on Method* (1637) and, at the other, by Immanuel Kant's three critiques of reason, the first of which was published in 1781.[87]

The second tradition is French and emphasized the origins of the French Renaissance in the return of travel reports on foreign cultures and places, such as Istanbul.[88] In the classic essay "Space and Humanism" (1946) Alphonse Dupront credits sixteenth-century writers, such as Jean Bodin (1530-1596) and Michel de Montaigne (1533-1592), with discovering the unity of human beings via the diversity of their appearances, as the latter appeared in travel reports.[89] As he put it: "The true fruit of the 'discovery of the world' is the certainty of a common humanity."[90] Dupront's approach has the virtue of including profound intellectual changes that occurred in the late Middle Ages with those wrought by the fifteenth and sixteenth centuries.[91] This long view

Blickpunkt Der Aufklärung (Berlin: Akademie-Verlag, 1978). On Eastern Europe, see Wolff, *Inventing Eastern Europe*, Mühlmann, *Anthropologie*, 13.

85 Wolff, *Inventing Eastern Europe*.

86 Jacob Burckhardt, "Entwicklung Des Individuums", in *Die Kultur Der Renaissance in Italien* (Berlin: Deutsche Buch-Gemeinschaft, 1961), Dilthey, "Die Funktion Der Anthropologie in Der Kultur Des 16. Und 17. Jahrhunderts." See also Krauss, *Zur Anthropologie Des 18. Jahrhunderts*.

87 Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton, NJ: Princeton University Press, 1979), Jacques Derrida, *Of Grammatology*, 1st American ed. (Baltimore, MD: Johns Hopkins University Press, 1976).

88 Geoffroy Atkinson, *Les Nouveaux Horizons De La Renaissance Française* (Paris: Droz, 1935), Michel Mollat, *Les Explorateurs Du Xiii Au Xvi Siècle: Premiers Regards Sur Des Mondes Nouveaux* (Paris: Éditions Jean-Claude Lattès, 1984), Geoffroy Atkinson, *La Littérature Géographique Française De La Renaissance* (New York: Burt Franklin, 1968). Alphonse Dupront, "Espace Et Humanisme", in *Genèses De Temps Modernes: Rome, Les Réformes Et Le Nouveau Monde*, ed. Dominique Julia and Philippe Boutry (Paris: Gallimard Le Seuil, 2001), 47.) This text was originally published as, ———, "Humanisme Et Renaissance", *Bibliothèque D'Humanisme Et Renaissance: Travaux & Documents* 8 (1946), François de Dainville, *La Géographie Des Humanistes*, Les Jésuites Et L'éducation De La Société Française (Paris: Beauchesne, 1940).

89 On Montaigne, see Donald M. Frame, *Montaigne's Discovery of Man: The Humanization of Humanist* (New York: Columbia University Press, 1955).

90 Dupront, "Espace Et Humanisme", 47.

91 For a similarly broad approach to intellectual history, see Steven E. Ozment, *The Age of Reform (1250-1550) : An Intellectual and Religious History of Late Medieval and Reformation Europe* (New Haven, CT: Yale University Press,

runs through the French scholarship of the second half of the twentieth century.[92]

Combining the geographic approach to anthropology with the rise of astronomy suggests an alternative interpretation: anthropology emerged in conjunction with *two* inherently spatial challenges, rather than just one.[93] The first came in 1492, when Christopher Columbus (1451-1506) encountered two new continents of which classical geography had been ignorant. Many scholars have considered the intellectual ramifications of this event for Europe.[94] The second occurred fifty-one years later, when Copernicus broke with geocentric cosmology and, thus, made extraterrestrial space an anthropological issue back on Earth.

These two spatial challenges yielded an intellectual superstructure, consisting of two spheres, concentrically aligned, that defined the space in which modern anthropology developed. We can understand the significance of parallel spheres for celestial anthropology against the backdrop of someone who only emphasized the terrestrial sphere, namely José de Acosta (1539-1600), a Spanish Jesuit who travelled the New World in the sixteenth century. The historian Anthony Pagden has identified Acosta as a key player in the birth of anthropology (Pagden uses the term enthnology), because the latter credited the indigenous peoples of the New World with having their own culture.[95] Pagden traces Acosta's interest in comparative ethnological analysis up through the work of the French Jesuit Jean François Lafitau (1681-1746), who analyzed the cultures of the indigenous peoples that lived in what is now Canada.[96] In a subsequent work, Pagden has extended this intellectual tradition up through the German anthropologist Johann Gottfried Herder (1744-1803).[97] This approach has two limitations. It misses the significance of geographic space to Acosta's work and overlooks the astronomical background to Herder's anthropological thought.

Acosta's anthropology was awash in the spatial knowledge that was pouring into colonial-era Spain. He was not a Copernican, although he may have been exposed to heliocentrism, since Spain hosted cautious streams of Copernican discussion.[98] His appraisal of indigenous peoples and their cultures actually began with geographic thought, as the first two books of his great

1980). On science, see Stephen Gaukroger, *The Emergence of a Scientific Culture: Science and the Shaping of Modernity, 1210-1685* (Oxford: Clarendon Press 2006).

92 Mollat, *Les Explorateurs_*, Duchet, *Anthropologie Et Histoire*.

93 Henri Lefebvre, *The Production of Space* (Oxford: Blackwell, 1991).

94 The classic work is Elliott, *The Old World and the New, 1492-1650*. See also Pagden, *The Fall of Natural Man*, ——, *European Encounters*.

95 Pagden, *The Fall of Natural Man*. See also Thayne R. Ford, "Stranger in a Foreign Land: Jose De Acosta's Scientific Realizations in Sixteenth-Century Peru", *The Sixteenth Century Journal* 29, no. 1 (1998).

96 On Lafitau, see also Krauss, *Zur Anthropologie Des 18. Jahrhunderts*.

97 Pagden, *European Encounters*.

98 Victor Navarro Brotons, "The Reception of Copernicus in Sixteenth-Century Spain: The Case of Diego De Zuniga", *Isis* 86, no. 1 (1995).

anthropological work *Natural and Moral History of the Indias* (1590) were a reprint of an earlier work entitled, *De natura novi orbis* ("*On the Nature of the New Globe*") (1588), which integrated the latest geographic knowledge with classical traditions.[99] By including this older work in *Natural and Moral History* Acosta inaugurated a crucial trend in anthropological thought that emphasized constructing environments before populating them with biological creatures. For example, the book itself described the New World's natural conditions, such as the wind, the soil and mineral riches, *before* mentioning the people that lived among them. Indeed, the first truly cultural analysis comes only in Book V —three hundred pages into the six-hundred-page tome— when it examines what it calls the locals' idolatry.[100] Already in the sixteenth century, culture followed space.

It is not surprising that, as a trained theologian, Acosta would apply Christian concepts to his object of study. More important, however, is his application of a capacious sense of space to his analysis of human life. Acosta used geographic space to create an environment that, in turn, shaped the destiny of the population —a way of thinking that ran up through Charles Darwin (1809-1882). Acosta's spatial approach to humanity was so sophisticated that in the *Natural and Moral History* he became the first to suggest that the indigenous peoples of the New World had migrated from Asia.[101] This was a stunning insight, given the limitations of the day, and its effects would echo well into the eighteenth century, particularly in the work of Georges-Louis Leclerc, the Comte de Buffon (1707-1788).

As significant as the European landing in the New World was for anthropology, it was the Copernican challenge that situated it within a larger conception of space. Published in Nuremberg, Copernicus's *De revolutionibus* led to a profound shift, as in contrast to the Aristotelian-Ptolemaic system, the heliocentric system had no "natural" center and no hierarchy of spaces.[102] Heliocentrism demanded, thus, a homogeneous space that was anchored neither in the terrestrial globe, nor in classical culture.[103] The diffusion of this spatial aesthetic took decades. Most important for anthropology was that it had two characteristics that recommended it to a European culture that was learning to think in terms of imaginary spheres: homogeneity and reflexivity.

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[99] Karl W. Butzer, "From Columbus to Acosta: Science, Geography, and the New World", *Annals of the Association of American Geographers* 82, no. 3 (1992).

[100] José de Acosta, *Historia Natural Y Moral De Las Indias* (Madrid: Alonso Martin, 1608), 303.

[101] Saul Jarcho, "Origin of the American Indian as Suggested by Fray Joseph De Acosta", *Isis* 50, no. 4 (1959).

[102] The best book on Copernicus' philosophical and cultural significance remains Blumenberg, *Genesis*. See also, Guerlac, "Copernicus and Aristotle's Cosmos.", Duhem, *Medieval Cosmology*, Grant, "The Medieval Cosmos." Granada, "Aristotle, Copernicus, Bruno."

[103] On the history of space, see Max Jammer, *Concepts of Space: The History of Theories of Space in Physics*, 2d ed. (Cambridge, MA: Harvard University Press, 1969), Koyré, *From the Closed World*. On medieval cosmology, see Pierre Maurice Marie Duhem, *Medieval Cosmology: Theories of Infinity, Place, Time, Void, and the Plurality of Worlds* (Chicago: University of Chicago Press, 1985), Edward Grant, "The Medieval Cosmos: Its Structure and Operation", *Journal for the History of Astronomy* 28 (1997).

The former overcame the fractured nature of medieval space, while the latter allowed people to imagine human spaces from the vantage point of extra-terrestrial ones. Together these accelerated the terrestrialization of the human being, by allowing the projection of the mind not merely around the globe but also beyond it.

Part IV

A detour through the history of globes can help us to understand more fully the early-modern approach to space.[104] Although the term globalization is on everyone's lips today, few people have considered how important it was (and remains) for Western thought to have a common image of the terrestrial and celestial globes. The first globe produced in Europe since classical times dates to 1490. In that year, Martin Behaim (1459-1507) returned to Nuremberg from seafaring Portugal and received a contract from city notables to construct a globe.[105] Completed in 1493, the resulting sphere highlights, as did Acosta's work, the complicated interplay of old and new within the Renaissance sense for space.[106] On the one hand, Behaim's globe has latitudinal and longitudinal lines, a technique first propounded by Ptolemy in the *Geographia*. (A modern translation of this text first appeared in 1477.)[107] On the other, it includes information brought back to Europe from intrepid medieval travelers, especially those, such as Marco Polo (1254-1324), who visited Asia. (Behaim himself was a traveler and some of the information on the African continent may have come from his own experiences.) Of course, Behaim omitted the New World, but this lacuna only reveals how profoundly significant spatial themes were to European intellectual development overall, as Renaissance spatial sense was already in ferment when the two great challenges hit Europe.

Behaim's globe marks the beginning of an important new trend that intensified the new spatial sense's effect on anthropology: globes made it possible to manipulate spaces that few could hope to see.[108] Behaim's single globe was almost immediately overtaken by the production of paired globes. In 1517, Johannes Schöner (1477-1547), a theologian turned globe maker,

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104 The history of globes is part of the history of cartography. It will, however, be understood separately here.

105 G. R. Crone, *Maps and Their Makers: An Introduction to the History of Cartography* (London: Hutchinson's University Library, 1953), 64-67.

106 Headley, "Geography and Empire."

107 Tony Campbell, *The Earliest Printed Maps, 1472-1500* (Berkeley, CA: University of California Press, 1987). The first edition was printed in Bologna. Two more editions followed, one published in Rome in 1478 and another in Ulm in 1486. Margriet Hoogvliet, "The Medieval Texts of the 1486 Ptolemy Edition by Johann Reger of Ulm", *Imago Mundi* 54 (2002).

108 Globes are a crucial aspect of the early-modern world's material culture. On material culture, see Leora Auslander, "Beyond Words", *American Historical Review* 110, no. 4 (2005). On astronomy and material culture, see Sara Schechner, "The Material Culture of Astronomy in Daily Life: Sundials, Science, and Social Change", *Journal for the History of Astronomy* 32 (2001).

produced the first pair of celestial and terrestrial globes in Nuremberg. Extensions of both Ptolemaic cosmology and the medieval orrery, which was a device that put a generic earthly sphere at the center of a ring that represented the zodiac, the construction of parallel spheres became standard across Europe, as a host of globe makers, such as Gerard Mercator (1512-1594) and Willem Janszoon Blaeu (1571-1638) in the Netherlands and Guillame Delisle (1675-1726) and Nicolas Bion (1652-1733) in France, adopted the practice.[109] Globes then spread around Europe and, by the end of the seventeenth century, were essential for any informed person. The diffusion continued well into the next century, when they became objects of consumption.[110] An excellent example is the appearance of pocket celestial and terrestrial globes, which a traveler could use as a means of orientation while away from home. (Figure 2.) Astronomical space had become so ubiquitous that one could carry it, if not in one's head, at least in one's pocket.

The pairing of the globes injected the two spatial challenges into Europe's material culture.[111] Paired globes assumed both homogeneous space and an extraterrestrial position, as terrestrial globes put viewers above the Earth and celestial globes put them on the other side of the celestial sphere. This perspective, akin to God's, was projected downward onto the terrestrial globe and, in turn, afforded the viewer a position that no human had (yet) attained. The mental journey downward from above was manifest in the use of latitudinal and longitudinal lines, which had been inherited from Ptolemy. These lines were not natural features, but intellectual markers projected onto the terrestrial globe from the perspective of the celestial one.[112] Life on our planet could, thus, at a stroke, be located and imagined via mental structures that were not be the subject of terrestrial experience.

By the eighteenth century, globes became one of the most important pedagogical tools available to the astronomical elite, as globe makers and astronomers worked closely together. Figure 3 is a German example of a celestial sphere, and it comes from the frontispiece to part one of Johann Wolfgang Müller's *Instruction on the Understanding and Use of Artificial*

109 Elly Dekker and P. C. J. van der Krogt, *Globes from the Western World* (London: Zwemmer, 1993), Jacob Hess, "On Some Celestial Maps and Globes of the Sixteenth Century", *Journal of the Warburg and Courtauld Institutes* 30 (1967).

110 On the diffusion of globes, see Tony Campbell, "A Descriptive Census of Willem Blaeu's Sixty-Eight Centimeter Globes", *Imago Mundi* 28 (1976). An eighteenth-century example: Samuel Fuller, *Practical Astronomy, in the Description and Use of Both Globes, Orrery and Telescopes, Wherein the Most Useful Elements, and Most Valuable Modern Discoveries of the True Astronomy Are Exhibited after a Very Easy and Expeditious Manner, in an Exact Account of Our Solar System, with Ten Curious Copper-Plates. Collected from the Best Authors, as Dr. Halley, Keil, Harris, Gordon, &C. For the Use of Young Students.* (Dublin: Samuel Fuller, 1732).

111 See also Headley, "Geography and Empire".

112 Copernicus, *De Revolutionibus*.

Celestial- and Terrestrial Globes...[113] Published in Nuremberg, this book and its companion volume, whose frontispiece we will consider below, served as manuals for their accompanying globes. In the center of the image is a celestial globe, around which lie the tools that, according to the text, make possible the globe's proper use.[114] Two assumptions determined what was proper. First, the globe needed to be oriented, which was done by finding both true north, using a compass that is located on the globe's base, and the true horizon, using a lead-weight scale that is not depicted. Second, the text asserts that however well oriented the sphere may be, it is a fiction, since the stars are actually located at different distances from earth.[115] Müller added, "Because here we consider only the universe as it appears to our eyes and not its true structure, which can only be studied through deeper investigation", *i.e.* through astronomy.[116]

Now, let us come down to Earth via Figure 4, which contains the frontispiece to part two of Müller's *Instruction*.[117] Here we see the terrestrial sphere, which the text assumed to be at the center of the celestial one. Accordingly, the user was expected to orient the object correctly, again using scientific instruments. More importantly, the text expressly notes that this sphere was a fiction, too, since the earth is not actually a sphere and the latitudinal and longitudinal lines were understood to be projections onto the earth from the celestial sphere.[118] Müller's globes are one example of a deep transformation in the European approach to the natural world. Across Europe people produced representations of the globe and the universe that everyone knew, nonetheless, were not meant to be accurate. To orient oneself with reference to the natural world required, thus, recognizing that human space began with imagined space. The intellectual effects of this realization's spread would be profound.

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113 Johann Wolfgang Müller, *Anweisung Zur Kenntnis Und Dem Gebrauch Der Künstlichen Himmels- Und Erdkugeln Besonders in Rücksicht Auf Die Neuesten Nürnberger Globen, Für Die Höhern Classen Der Schulen Und Liebhaber Der Sphaerologie*, 2 vols., vol. I (Nuremberg: Johann Georg Klinger, 1791).

114 ———, *Anweisung Zur Kenntnis Und Dem Gebrauch Der Künstlichen Himmels- Und Erdkugeln Besonders in Rücksicht Auf Die Neuesten Nürnberger Globen, Für Die Höhern Classen Der Schulen Und Liebhaber Der Sphaerologie*, 2 vols., vol. 2 (Nuremberg: Johann Georg Klinger, 1792).

115 *Ibid*., 2.

116 *Ibid*., 3-4.

117 *Ibid*., 27-80.

118 *Ibid*. This point is especially clear in the chapter "Von der mathematischen Abtheilung der Erdoberfläche", Müller, *Anweisung Zur Kenntnis, Vol. Ii* 307-08. On the shape of the Earth, see Mary Terrall, *The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment* (Chicago: The University of Chicago Press, 2002).

Part V

Against the backdrop of imagined space, let us turn back to the seventeenth century, in order to understand the problems that globe makers and astronomers were creating and to which they were responding. One important result of the two spatial challenges —and a clue to astronomy's cultural significance— was the feeling, among some Europeans, of being uprooted, lost in all the new space. In 1611, John Donne wrote:

> T'is all in peeces, all cohaerence gone;
> All just supply, and all Relation:
> Prince, Subject, Father, Son, are things forgot,
> For every man alone thinkes he hath got
> To be a Phoenix, and that then can bee
> None of that kind, of which he is, but hee.[119]

Donne's pique points our attention to a problem created by seventeenth-century astronomy: the universe kept getting bigger.[120] As we saw above in Lambert's work, eighteenth-century astronomers accepted the infinity of the universe. The seventeenth century, however, was only beginning to come to terms with the idea. One response to confrontation with immensity came from Blaise Pascal, who in 1654 cried out in his Pensées, "The eternal silence of these infinite spaces frightens me. How many realms are unaware of us!"[121] As a mathematician and geometer almost without peer, Pascal understood how to project space, so his existential hand wringing was not simply the result of his feeling lost within the vertiginous realms of outer space. Instead, his anguish also reflects the reflexivity of early-modern post-Copernican space: in a Copernican universe other spatial realms may exist that are unaware of our realm. In this context, homogenous space challenged Pascal's religious identity, because, in addition to being infinite, this space assumed that extraterrestrial spaces were equal to Pascal's own.[122]

Astronomers and their allies recognized the depth of the problem and entered the breach with a variety of pedagogical works that normalized space

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[119] Charles M. Coffin, ed. *The Complete Poetry and Selected Prose of John Donne* (New York: The Modern Library,2001), 192.

[120] Koyré, *From the Closed World*.

[121] Blaise Pascal, *Pensèes* (Paris: GN-Flammarion, 1976), 110. Margaret C. Jacob, *The Newtonians and the English Revolution, 1689-1720* (Ithaca, N.Y.: Cornell University Press, 1976), Simon Schaffer, "Authorized Prophets: Comets and Astronomers after 1759", *Studies in Eighteenth-Century Culture* 17 (1987), Secord, "Newton in the Nursery: Tom Telescope and the Philosophy of Tops and Balls, 1761-1838.", Sarah Hutton, "Emilie Du Chatelet's Institutions De Physique as a Document in the History of French Newtonianism", *Studies in the History of the Philosophy of Science* 35, no. 3 (2004).

[122] I am indebted to Prof. Stephen Schloesser, SJ of Boston College for highlighting how significant the inwardness in Pascal's thought is for the argument made here.

via methods of projection and orientation. In 1686, Bernard de Fontenelle (1657-1757), permanent secretary of the *Académie des Sciences* and well informed on astronomical matters, confronted these fears in his *Conversations on the Plurality of Worlds*, when he had a character, Madame la Marquise G***, say:

> But with a universe so large, I will be lost, will no longer know where I am, will no longer know anything. All this immense space that our sun and our planets comprise will only be a small parcel of the universe? As many similar spaces as there are fixed stars? This confounds me, troubles me, terrifies me.[123]

A reflection of the gendering inherent in the concept Man, the book's main character (who is really Fontenelle himself) calmed the Marquise by explaining in dulcet tones the universe's structure to her.[124] *Conversations* became famous quickly and was republished often through the seventeenth and eighteenth centuries.

The same stunned awe appeared some fifty years later in the work of the German poet and science popularizer Johann Christoph Gottsched (1700-1766). In his *First Principles of all Worldly Wisdom* (1733-34), he wrote:

> Here sense and wit stare into space, the mind loses itself entirely among the number, splendor, order, movement and brilliance of all these worlds. Oh! What is man in comparison?[125]

And the response to infinite space was the same: greater popularization. Gottsched published many works that diffused the new astronomical knowledge.[126] Indeed, his work is an extension of Fontenelle's, as he was the first to translate *Conversations* into German.[127]

Fontenelle and Gottsched represent only a small part of the pedagogical response to Donne's disorientation. In 1669, for example, as small book appeared in Tübingen under the title, *Short Instruction on Making Artificial Maps According to Proper Grounds…* The author was the astronomer Wilhelm Schickard (1592-1635), who succeeded Kepler's teacher, Michael Maestlin

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123 Bernard de Fontenelle, *Entretiens Sur La Pluralité De Mondes* (Berlin: Chrétien Frédéric Himburg, 1783).

124 Along similar lines, see Mazzotti, "Newton for Ladies." See also Secord, "Newton in the Nursery: Tom Telescope and the Philosophy of Tops and Balls, 1761-1838."

125 Johann Christoph Gottsched, *Erste Gründe De Gesammten Weltweisheit, Darinn Alle Philosopische Wissenschaten, in Ihrer Natürlichen Verknüpfung, in Zwenen Theilen Abgehandelt Werden*, 6th ed., 2 vols. (Leipzig: Bernhard Christoph Breitkopf, 1756), (frontispiece).

126 Walter Schatzberg, "Gottsched as a Popularizer of Science", *MLN* 83, no. 5 (1968).

127 Bernard le Bovier Fontenelle, *Herrn Bernhards Von Fontenelle Gespräche Von Mehr Als Einer Welt Zwischen Einem Frauenzimmer Und Einem Gelehrten: Nach Der Neuesten Frantzösischen Auflage Übersetzt, Auch Mit Figuren Und Anmerckungen Erläutert* trans. Johann Christoph Gottsched (Leipzig: Bernhard Christoph Breitkopf, 1726).

(1550-1631), to the chair in astronomy at the University of Tübingen.[128] The introduction announced that the book's purpose was to use astronomy to stimulate the improvement of Germany's maps, with the ultimate goal of:

> Giv[ing] a hand not only to the traveler but also the homebody that amuses and improves himself by reading works of…world history, [should they be] led astray in the darkness and become ensnared in error —in body or mind— and [find themselves] at a loss, lost in the world. And for this reason the geographers, who here carry the light forward and help [us] out of this error, prefer Astronomy.[129]

The ability to imagine spaces that one could neither see nor comprehend demanded structures that situated the human being. An example appeared three years later in France, the *Treatise on Geography, which Provides Knowledge of the Use of both the Globe and the Map with the Illustrations Necessary for the Subject* by the geographer Pierre Duval (1618-1683). He wrote:

> those who know geography have a great advantage when reading history. And they recognize that the map gives them great clarity in all affairs. They avow that nothing less befits man over beasts than to know the layout of his home and to receive pleasure from traveling without peril in distant regions.[130]

Astronomy stood on the outside looking in and created the conceptual structures that made it safe to think about not only the natural world but also human history.

Spatial pedagogy even penetrated into the world of non-specialists. Consider *Idea of the World, or Easy and Methodical Introduction to Cosmography and History* (1690), a cosmographical work that put all of human experience into a cosmological context and was published by Samuel Chappuzeau (1625-1701).[131] Significantly, Chappuzeau was not an astronomer,

[128] Both Schickard and his book emerged from a rich astronomical backdrop. His chair in astronomy was historically significant, because of its age (it was founded in 1511) and, more importantly, because Maestlin had been Johannes Kepler's teacher. Charlotte Methuen, "Maestlin's Teaching of Copernicus: The Evidence of His University Textbook and Disputations", *Isis* 87, no. 2 (1996). On Kepler's time in Tübingen, see Caspar, *Kepler*.

[129] Wilhelm Schickard, *Kurze Anweisung Wie Künstliche Land-Tafeln Auss Rechtem Grund Zu Machen/ Und Die Biss Her Begangne Irrthumb Zu Verbessern/ Sampt Etlich New Erfundenen Vörtheln/ Die Polus Höhin Auffs Leichtest/ Und Doch Scharpff Gnug Zu Forschen* (Tübingen: Johann Georg Cotta, 1669), (unpaginated).

[130] Pierre Duval, *Traité De Geographie Qui Donne La Connoissance Et L'usage Du Globe Et De La Carte Avecque Le Figures Necessaires Pour Sujet* (Paris: Chez l'Auteur, en l'Isle du Palais sur le Quay de l'Orloge, au coin de la Rue de Harlay, 1672), preface (unpaginated).

[131] Samuel Chappuzeau, *Idée Du Monde, Ou Introduction Facile & Methodique a La Cosmographie Et a L'histoire* (Celle: André Holven, 1690).

or even a mathematician, but a dramatist whose work influenced Molière.[132] His work, give us, therefore, a sense of the extent to which astronomical knowledge had entered broader intellectual realms. Born in France, Chappuzeau moved through various social realms in France, the Netherlands, where he befriended Constantijn Huygens, father of the physicist Christiaan, and Germany, where he spent the last two decades of his life at the court of the Duke of Brunswick and Lüneburg. He was, in all respects, a typical product of Baroque sociability: involved in a broad array of activities, he surely encountered the newest scientific doctrines and likely imbibed the cosmopolitanism that science inspired.[133]

Chappuzeau exemplifies how celestial anthropology moved from the outside in. The text is divided into three parts, with the first using a discussion of abstract and astronomical space to create a place for life. This part orients the reader by discussing the sphere in general, before explaining the structure of the universe and then the globe, including an astronomical explanation of the climate.[134] Here are the first words of chapter 1:

> The sphere is a solid body contained under one surface, in the middle of which there is a point called the center, and from which all lines drawn are equal among themselves. Flat spherical images, such as those showing us geographic maps and *Mappemondes* are only an imitation of a solid sphere.[135]

Chappuzeau reveals that, by the end of the seventeenth century, knowledge about the world began with abstract space. This approach then extends through the second part of the work, which begins with geography, before turning to a discussion of where people lived and then considering the commercial networks they developed. The final part covers the history of all parts of the globe, beginning with the ancient Assyrians and then running through the New World. Astronomy also became the ultimate backdrop to history.

During the eighteenth century, astronomers busily diffused spatial knowledge via ever more pedagogical works, including astronomical textbooks. Almost all of the latter included either a tutorial on abstract space, or express reference to the need to understand it before proceeding with deeper study. The role of spatial knowledge is illustrated in a textbook, published in 1708, by Johann Gabriel Doppelmayr, a German astronomer:

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132 William Brooks, "Chappuzeau and the Orateur: A Question of Accuracy", *The Modern Language Review* 81, no. 2 (1986), C. J. Gossip, "The "Orateur" In Seventeenth-Century French Theatre Companies", *The Modern Language Review* 101, no. 3 (2006).

133 Margaret C. Jacob, *Strangers Nowhere in the World: The Rise of Cosmopolitanism in Early Modern Europe* (Philadelphia, PA: University of Pennsylvania Press, 2006).

134 Chappuzeau, *Idée Du Monde*, 45-52.

135 *Ibid*., 1-2.

> We begin in the middle of our system and suppose that we are standing in the middle of the Sun [looking out] with our own eyes and that in no direction is there a hindrance, neither from the [Sun's] body nor [its] strong light.[136]

Doppelmayr's work is only one example of how astronomy oriented the human mind without reference to terrestrial experience.[137] By beginning with the interior of the Sun, he assured his readers that they could look beyond appearances, in order to see the world and the universe truly. It is, thus, significant that he was also an important producer of celestial and terrestrial globes.[138] Imagined space (whether in written or physical form) served a larger mission of celestial orientation. For that reason the distinction that many historians have made between books and material culture cannot be applied so neatly here.[139] Spatial thought made books part of material culture and globes part of print culture.

Astronomy created the tools with which the larger populace oriented itself. In 1740, Jacques Cassini (1677-1756), director of the Paris Observatory and scion of an astronomical family, described astronomy, thus:

> Astronomy is a science that has as its object the contemplation of all the heavenly bodies. It teaches how to determine their position in the the sky, their movement and distance....It is by its assistance that one can discover the size of the earth and its shape, the position of all its parts, each in regard to the other, as well as to understand their boundaries and everything concerning geography.[140]

The spatial agenda also penetrated into children's books. One book on astronomy and geography, published anonymously in 1776, held:

> This science, necessary and agreeable in whatever condition one be, is brought today to such a point of perfection that to our eyes the entire world is scarcely a large city and all the people that occupy it together a great family.[141]

Learning to look down had anthropological effects. Figure 5 is the frontispiece to this work, and it brings together many of the themes that we have considered thus far. On the one hand, we see people looking to the sky. On the other, we see a precocious Atlas holding up the celestial sphere that

[136] Pierre Simon de Laplace, *Exposition Du Système Du Monde*, 4th ed. (Paris: Courcier, 1813; reprint, 2005).
[137] On this point, see Blumenberg, *Genesis*.
[138] Dekker and Krogt, *Globes from the Western World*.
[139] For classic statement of this position, see Auslander, "Beyond Words." On material culture and astronomy, Schechner, "The Material Culture of Astronomy in Daily Life: Sundials, Science, and Social Change."
[140] Jacques Cassini, *Éléments D'astronomie* (Paris: L'Imprimerie Royale, 1740), iii.
[141] *Nouvel Atlas Des Enfans, Ou Principes Clairs Pour Apprendre Facilement Et En Fort Peu De Tems La Geographie, Suivi D'un Traité Méthodique De La Sphere, Qui Explique Le Mouvement Des Astres, Les Divers Systemes Du Monde, & L'usage Des Globes*, (Amsterdam: Chez B. Vlam, 1776), v.

astronomical observation had produced.[142] Even at the level of symbols, the extra-terrestrial defined the terrestrial.

This last point provides us with a clue to the larger significance of orientation for European thought: in addition to making people feel secure in the world, space also became a method of domination in the seventeenth- and eighteenth centuries. Spatial dominance is on display, for example, in a travel report of a group of explorers in New South Wales, Australia, written in the year 1791. Of one expedition the group's leader, Watkin Tench, wrote, "at a very short distance from Rose Hill we found that they [the aboriginal guides] were in a country unknown to them; so that the farther they went, the more dependent on us they became, being absolute strangers inland."[143] Things were not quite so bad for the English, according to Tench, because they had brought with them an astronomer, who tracked the group's movements and calculated their position daily with the result that, "we always knew exactly where we were and how far from home" —and this apparently even when the expedition was completely lost.

The ability to dominate space permeated European thought. Let us return to Figure 4. Now, however, we want to examine the images that surround the terrestrial globe in the center. On the left is a ship flying the Tricolor, thus, representing French exploration. In the middle is Australia, called Hollandia, which the Dutch only encountered in 1606 and the British first settled in 1788. To the right are British troops firing on indigenous people in Hawai'i, which is probably a reference to the misunderstanding that led to James Cook's death in 1776. In this context it is important to understand that early-modern Germany had no colonial tradition. Still, its spatial thinkers expressly injected the European colonial rivalry into their understanding of space, as the explorations of other powers became the foundation for the German geographic imagination. We are dealing, thus, with a broad European approach to space that had, in turn, great effects on early-modern Europe's understanding of anthropology.

The ability to use celestial markers to understand one's location was an important theme in all of European thought. A classic example comes from 1786, when Immanuel Kant published a journal article entitled "What is Orientation in Thinking?" Here he defined orientation thus: "To orient oneself means, in the literal meaning of the word: to find the sunrise from a given region of the world, [given that] we divide the Horizon into four parts. If I see the Sun in the sky, and know that it is afternoon, now I know how to find south, west, north and east."[144] Kant is expressing something that was essential to his philosophy, namely that left and right, north and south, etc.,

[142] On Atlas imagery in early-modern astronomy, see Mosley, *Bearing the Heavens*.
[143] Quoted in Simon Schaffer, "Instruments, Surveys and Maritime Empire", in *Empire, the Sea and Global History; Britain's Maritime World, C. 1760-C.1840*, ed. David Cannadine (Houndmills: Palgrave Macmillan, 2007), 85.
[144] Immanuel Kant, "Was Heißt: Sich Im Denken Orientiren?", *Berlinische Monatsschrift* (1786).

only take on meaning in a world that our reason is designed to apprehend. It is significant, therefore, that the sense of place that undergirds Kant's ideas about orientation is based on the combination of celestial with terrestrial markers, neither of which can be experienced directly by the human subject. Like latitude and longitude, north, south, east and west do not actually exist, but are human projections onto the natural world.

Thanks to the growth of astronomy, phenomena that no one could directly experience became the basis for constructing a world. Those that lacked the requisite knowledge (women and children) were to be tutored in space by luminaries such as Fontenelle. Those without the possibility of being tutored in space, i.e. indigenous colonial peoples, were simply dominated by it. Astronomy and its accompanying discipline of geography are, therefore, the conceptual bedrock on which what Edward Said has called "Orientalism" was built.[145] If Europeans turned the Orient into a place, and in a way that denied local peoples their own identity, it was the result of their having invented the tools necessary for imagining foreign places —tools that, for a variety of reasons, the people living in the Orient and other colonial regions had failed to develop to the same degree, if at all. The Europeans could be "the lords of all that they surveyed", as Louise Pratt has put it, precisely because they could *survey* everything and, on that basis, produce maps and globes that made spatial knowledge a common intellectual inheritance.[146] Colonial dominance and sophisticated spatial thought went hand-in-hand.

Part VI

Having considered the backdrop for the rise of celestial anthropology, we turn now to an intellectual genealogy, with an emphasis on the crossover points between anthropology and astronomy. We will consider five writers who, between 1700 and 1850, produced works that most clearly defined this intellectual current's glory days. The first signs of what would become celestial anthropology appear in the work of the great Dutch physicist Christiaan Huygens (1629-1695). A product of the Universities of Leiden (1575) and The College of Orange at Breda (1646) —he began with law, before turning to mathematics— he was a member of the *Royal Society* in London and the *Académie de Sciences* in Paris and made important contributions in the realms of physics, optics and horology.[147] In 1697, his final written work was

[145] Edward W. Said, *Orientalism*, Vintage Books ed. (New York: Vintage Books, 1979).
[146] Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London: Routledge, 1992).
[147] Christopher Baker, ed. *Absolutism and the Scientific Revolution, 1600-1720: A Biographical Dictionary* (Westport, CT: Greenword Press,2002), 187-88.On the world from which Huygens came, see Klaas van Berkel, Albert van Helden, and Lodewijk Pal, eds., *A History of Science in the Netherlands: Survey, Themes and Reference* (Leiden: Brill,1999), 37-67. On Huygens in Paris, see Geoffrey V. Sutton, *Science for a Polite Society: Gender, Culture, and the Demonstration of Enlightenment* (Boulder, CO: Westview Press, 1995), 119-23. On Dutch higher education, see Jonathan I. Israel, *The*

published posthumously in Latin, appearing again the following year in English translation under the title *Cosmotheoros: The Celestial Worlds Discover'd: or, conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets*.[148] This text combined Copernican cosmology and Newtonian physics with a much older debate known as the Plurality of Worlds, which concerned whether there was intelligent life on other planets. The Plurality of Worlds debate has a long pedigree, dating back to the classical world and we will return to its early-modern component in the next section.[149]

Cosmotheoros refined the Copernican spatial agenda by combining it with Newtonian physics and then applying both to biological life. It represents, thus, a break in both chosen audience and in method, as Fontenelle spoke to an elite that enjoyed the dialogue format. Unlike Fontenelle's work, to which it responds directly, Huygens' was not meant to entertain, but to educate according to a spatially organized plan.[150] Huygens hailed from a different social world and, unlike Fontenelle who subscribed to Cartesian physics, he was a full-blown Newtonian who wanted to bring science to a broader social stratum. After spending the first few pages discussing the possibility of extraterrestrial life, Huygens turned to space, presenting Copernicus' system as a spatial construct and including an image of the Copernican system similar to the original that we have seen in Figure 1.[151] He then entered into a series of proofs about why it explained more than the Ptolemaic one.

Like the astronomical work of the eighteenth century, Huygens' work projected the human mind into extra-terrestrial spaces. To do this he relied on geometry, which he understood only too well, and which allowed him to orient his readers via the projection of spheres. One cannot readily experience other worlds, but one can understand them in the abstract as big round spaces. Huygens' work is an important moment for the history of celestial anthropology, because his overt reliance on geometry licensed the liberal use of analogy. At the celestial level, geometry anchored beings in a world, making it possible to imagine a place without its being seen. Thus, Huygens held that, as spheres, other planets in our system probably hosted life, as did our own.[152] Analogy, in this context, works within the outside-in structure of astronomical thought, as Huygens constructs all of the worlds in

Dutch Republic: Its Rise, Greatness, and Fall, 1477-1806, Oxford History of Early Modern Europe (Oxford: Oxford University Press, 1995), 569-75.

148 Christiaan Huygens, *The Celestial Worlds Discover'd: Or, Conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets* (London: Timothy Childe, 1698).

149 Steven J. Dick, *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant* (Cambridge: Cambridge University Press, 1982), Michael J. Crowe, *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell* (Cambridge Cambridge University Press, 1986), George Basalla, *Civilized Life in the Universe: Scientists on Intelligent Extraterrestrials* (Oxford: Oxford University Press, 2006).

150 On Fontenelle's mixture of science with court etiquette, see Sutton, *Science for a Polite Society*, 149-54.

151 Huygens, *Celestial Worlds*, 11.

152 Christian Huygens, *The Celestial Worlds Discover'd: Or Conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets* (London: Timothy Childe, 1698), 17-19.

our solar system from an extraterrestrial perspective, putting himself above these planets and arguing that, as spheres, they probably also have water, which means they have plants, higher animals that eat the plants, and higher beings that eat everything. He then populates them with intelligent beings who are endowed with reason, senses and language.[153]

The link between projecting space and the birth of celestial anthropology is clearest when Huygens considers otherworldly systems of knowledge.[154] He begins with astronomy, arguing that any intelligent being's eyes must be drawn naturally to the stars. For that reason all intelligent life in our system will have developed astronomy, as well as other methods of spatial reckoning, including arithmetic, geometry, writing and optics. Not coincidentally, all but one of these are spatial disciplines, and Huygens' explicit association of these with astronomy confirms how spatial thought suffused the entire early-modern system of knowledge.[155] Huygens then holds that beings on other planets will surely have hands and walk upright as we do, although their bodies may be shaped differently than our own. This result was an important aspect of celestial anthropology: the visualization of space from the outside in made the concept of intelligent life exportable to other planets.

Now, we consider another thinker rarely credited with contributing to the birth of anthropology, the German philosopher Christian Wolff (1679-1754).[156] He studied mathematics and physics at the University of Jena (1558) and became a professor at, first, the University of Halle in Prussia (1691) and, later, the University of Marburg in Hessen (1527). His works ranged widely and dictated the direction of German philosophical and theological debates up to the end of the eighteenth century.[157] Wolff is more important to the rise of European anthropology than he has been assumed. He heavily influenced Germany's greatest eighteenth-century anthropologists, Kant and Herder (especially on the question of extraterrestrial life), and his thought was important to the emergence of biological thought in France, where it

153 *Ibid*., 37-39.

154 Huygens, *Celestial Worlds*, 61-66.

155 On the constellation of disciplines that undergirded the early-modern spatial sense, see the comments on mixed mathematics in John L. Heilbron, *Elements of Early Modern Physics* (Berkeley, CA: University of California Press, 1981).

156 An exception is Kim, *Die Entstehung Der Kantischen Anthropologie*.

157 Notker Hammerstein, "Christian Wolff Und Die Universitäten. Zur Wirkungsgeschichte Des Wolffianismus Im 18. Jahrhundert", in *Christian Wolff, 1679-1754*, ed. Werner Schneiders (Hamburg: Felix Meiner Verlag, 1983), Thomas P. Saine, "Who's Afraid of Christian Wolff?", in *Anticipations of the Enlightenment in England, France, and Germany*, ed. Alan Charles Kors and Paul J. Korshin (Philadelphia: University of Pennsylvania Press, 1987), Gunter E. Grimm, "Vom Schulfuchs Zum Menschheitslehrer", in *Über Den Prozess Der Aufklärung in Deutschland Im 18. Jahrhundert: Personen, Institutionen Und Medien*, ed. Hans Erich Bödeker and Ulrich Herrmann (Göttingen: Vandenhoeck & Ruprecht, 1987), Frederick C. Beiser, *The Fate of Reason: German Philosophy from Kant to Fichte* (Cambridge, Mass.: Harvard University Press, 1987). For an evaluation of Wolff that emphasizes how he was superseded by Immanuel Kant, see Linden, *Untersuchungen*. For an example of his influence on anthropological thought, see Karl Franz von Irwing, *Erfahrungen Und Untersuchungen Über Den Menschen*, 4 vols., vol. 4 (Berlin: Verlage der Realschulbuchhandlung, 1785). On Wolff's influence in German astronomy, see Schaffer, "Authorized Prophets."

influenced a circle of thinkers that included the Comte de Buffon.[158]

In 1725, Wolff published his *Reasonable Thoughts on the Workings of Nature*, which summarized Europe's knowledge of the natural world.[159] A more organized version of Huygens' *Cosmotheoros*, it discusses every imaginable detail of the universe, including the possibility of extraterrestrial life. Wolff took many basic themes directly from Huygens, although without showing the grace to cite him. This critique aside, *Reasonable Thoughts* reaffirms the conceptual progression that became basic to eighteenth-century anthropological thought: the movement from abstract space to cosmological space to human space. He began the text by explaining bodies in the abstract, offering a tutorial in geometry before describing our solar system and then ending with the earth, its weather, geography and organic life. The title of this tutorial is "On the Nature of Bodies and their Properties in General."[160] It comprises the first part of the book and runs to 150 pages. Section two of the book carries the title "On the World Edifice", and discusses the Sun, the then-known six planets, as well as the Moon and other bodies, such as stars and comets in 120 pages more.[161] Section three is entitled "On the Conditions of the Earth" and explained the earth's geography, topography, climate and a host of natural forces such as lightning in the next 240 pages.[162]

The final section of the book was entitled "On Plants, Animals and Human Beings." The progression of entities named in this title highlights the endpoint of celestial anthropology. First, it makes clear that all the world's food is based on plant life, beginning with its description of how plants grow before moving on to how human beings and animals eat the plants, if not each other. Second, drawing on the cosmological agenda we have already seen, it discusses human beings and other higher animals, but only after a discussion of plant life. Overall, the human being appears only 620 pages into the 750-page work. Now, we are in a position to note the most significant turning-point in the history of anthropological thought: during the first half of the eighteenth century, anthropology not longer began with Man but *ended* with him —a logical progression that exerted enormous influence on subsequent thinkers.

From Wolff we turn to the Comte de Buffon, whose multi-volume *Histoire Naturelle* (1749-88) is the most important anthropological work published in the eighteenth century.[163] Michèle Duchet begins her path-breaking history of French anthropological thought with Buffon, and rightly so, because he

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158 Phillip R. Sloan, "Buffon, German Biology, and the Historical Interpretation of Biological Species", *The British Journal for the History of Science* 12, no. 2 (1979). More broadly, see Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: Belknap Press, 1982), 102, 07.

159 Christian Wolff, *Vernünfftige Gedancken Von Der Würckungen Der Natur* (Halle: Rengerischen Buchhandlung, 1725).

160 *Ibid*., 1-150.

161 *Ibid*., 151-271.

162 *Ibid*., 271-560.

163 Georges-Louis LeClerc Buffon, Comte de, *Histoire Naturelle, Générale Et Particuliére Avec La Description Du Cabinet Du Roy*, 29 vols., vol. 1 (Paris: L'Imprimerie Royale, 1749-1788).

refined the cosmological outlines within which human beings situated themselves up through Alexander von Humboldt (1769-1859).[164] A product of the Universities of Dijon (1722) and Angers (1356), Buffon began studying law before switching to mathematics and science. He was also a protégé of an important French minister, Jean-Frédéric Phélypeaux, comte de Maurepas (1701-1781), who helped him to gain admission to the *Académie des Sciences* and to become director of the *Jardin du Roi*, from which position he heavily influenced European botanical thought. Buffon, thus, moved in an elite world of education and sociability that nurtured important both the natural sciences and anthropology.[165]

Buffon's work is a fully developed version of the agenda propounded by Wolff. It begins with a construction of the world in which human beings live, and then places them within a biological network that exists on (and is limited to) this planet. Buffon's approach was enormously influential.[166] The *Histoire Naturelle* was republished numerous times and translated into multiple European languages and had extensive influence over a broad area, framing the debate not only Kant and Herder but also other important anthropological thinkers, such as the physician Petrus Camper (1722-1789) and the anatomist Friedrich Blumenbach (1752-1840), as well as the naturalist Georg Forster.[167]

As with Wolff, we will approach Buffon's work architectonically. Buffon prefaces the first volume of his *Natural History* (1748) with two discourses, the second of which is entitled, "History and Theory of the Earth", which offered a view of how the Earth may have come to be formed well before any humans tread upon it.[168] From there, he considers various cosmological systems then in discussion, before describing —two hundred pages in— geography, the science of natural spaces.[169] Human beings do not appear in Buffon's work until the end of the second volume, where they are presented in a section entitled the "Natural History of Man", which comes just after "Natural History of Animals", an arrangement that reduces the humans to one

164 Duchet, *Anthropologie Et Histoire*.

165 Jacques Roger, *Buffon: A Life in Natural History* trans. Sarah Lucille Bonnefoi (Ithaca: Cornell University Press, 1997).

166 Mayr, *Biological Thought*, 101-02, Deidre Dawson and Pierre Morère, *Scotland and France in the Enlightenment*, Studies in Eighteenth-Century Scotland (Lewisburg, PA: Bucknell University Press, 2004), 192-212.

167 See, for example, Peter Camper, *Disseration Sur Les Variétés Naturelles Qui Caractérisent La Physionomie Des Homme Des Divers Climats Et Des Différens Ages...* trans. H. J. Jansen (Paris: Chez Francart, 1792), Johann Friedrich Blumenbach, *Über Die Natürlichen Verschiedenheiten Im Menschengeschlechte*, trans. Johann Gottfried Gruber (Leipzig: Breitkopf und Härtel, 1798). Blumenbach is a key figure in the development of physical anthropology. John Gascoigne, "Blumenbach, Banks, and the Beginning of Anthropology at Göttingen", in *Göttingen and the Development of the Natural Sciences*, ed. Nicolaas A. Rupke (Göttingen: Wallstein Verlag, 2002). On Forster, see H. West, "The Limits of Enlightenment Anthropology: Georg Forster and the Tahitians", *History of European Ideas* 10, no. 2 (1989), Erwin Ackerknecht, "George Forster, Alexander Von Humboldt, and Ethnology", *Isis* 46, no. 2 (1955). Blumenbach is also very important to emerging notions of race. John Zammito, "Policing Polygeneticism in Germany, 1775: (Kames,) Kant, and Blumenbach", in *The German Invention of Race*, ed. Sara Eigen and Mark Larrimore (Albany, NY: State University of New York Press, 2006).

168 Duchet, *Anthropologie Et Histoire*.

169 On cosmological systems: Buffon, *Histoire Naturelle*, 168-203. On geography: ———, *Histoire Naturelle*, 204-228.

among many terrestrial species.[170] Man is the sole subject of the third volume, which offers an anatomical analysis of the human body, beginning with the bones and working its way outward.[171] (This approach heavily influenced Blumenbach.) All told, of the original twenty-nine volumes (supplements were also published) only two deal with the human being, whereas the rest are dedicated to describing the natural world in which Man had his place.[172]

Now, we turn our attention to two key figures in the birth of German Anthropology, Immanuel Kant and Johann Gottfried Herder. In Kant's case celestial anthropology flows through multiple texts, although in a way that leads to a rejection of this approach's fundamental premises. Like the other thinkers discussed above, Kant was a product of an elite education, having studied at the University of Königsberg (1544), where he imbibed the philosophies of Leibniz and Wolff and the physics of Newton.[173] In 1750, he became a professor at the university and embarked on an academic career that included a good deal of socializing in elite circles.[174] Kant was, thus, like all the people discussed so far, informed on the latest science.

The first stirrings of Kant's celestial thought appeared with the publication in 1755 of *General Natural History and Theory of the Heavens*. In this text Kant offers a Newtonian overview of the universe's structure, expressly taking Huygens as his starting point.[175] He begins with the stars, projecting his mind outward and explaining how each star is the center of a system, probably alike to our own, and then explicates what is now called the nebular hypothesis. First proposed in 1734 by Emmanuel Swedenborg (1688-1772), this theory holds that, over time, clouds of matter form stars and planetary bodies.[176] Kant then turns to some general speculations about the virtues of a developmental approach to the universe, before speculating on extra-terrestrial life, in part three of the book, which is entitled "On the Inhabitants of the Stars."[177] Here he holds that extraterrestrial beings may exist, though not necessarily on every planet. This is another version of the classic progression of celestial anthropology: understanding outer space

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170 Georges-Louis LeClerc Comte de Buffon, *Histoire Naturelle, Générale Et Particuliére Avec La Description Du Cabinet Du Roy*, 29 vols., vol. 2 (Paris: L'Imprimerie Royale, 1749-1788), 429-603.

171 ———, *Histoire Naturelle, Générale Et Particuliére Avec La Description Du Cabinet Du Roy*, 29 vols., vol. 3 (Paris: L'Imprimerie Royale, 1749-1788).

172 Jean Ehrard, *L'idée De Nature En France Dans La Première Moitié Du Xviiie Siècle* (Geneva: Slatkine, 1981).

173 On the philosophical backdrop to Kant's views of physics, see William Clark, "The Death of Metaphysics in Enlightened Prussia", in *The Sciences in Enlightened Europe*, ed. William Clark, Jan V. Golinski, and Simon Schaffer (Chicago: University of Chicago Press, 1999).

174 Manfred Kuehn, *Kant: A Biography* (New York: Cambridge University Press, 2001).

175 Kant, *Werkausgabe*, 257.

176 *Ibid*., 273-78. Signe Toksvig, *Emmanuel Swedenborg: Scientist and Mystic* (New Haven, CT: Yale University Press, 1948), 71-73. Buffon had a copy of the work in which Swedenborg proposes the nebular hypothesis. Edward S. Holden, ed. *Essays in Astronomy* (New York: D. Appleton and Company,1900), xvii.

177 Kant, *Werkausgabe*, 377-96.

precedes the discussion of life on any of the bodies in the universe.[178]

Kant's intervention in the Plurality of Worlds debate is an early sign of his deep and abiding interest in anthropology.[179] In the early Kant anthropology is expressly spatial, as sentient beings were *of* the sphere that they inhabited. As Kant noted, "The Earth's and Venus' inhabitants cannot exchange their homes without their mutual destruction."[180] This position emerged from the work of the biologist Albrecht von Haller, a professor at the University of Göttingen (1737), who described the human body as a sack full of juices. Given the differences in environments between the two planets, it seemed clear to Kant that the human body could not survive the environmental extremes of Venus, or any other planet for that matter. Kant's desire to limit Man to his sphere was, however, also a product of the humility that coursed through Pope's "Essay on Man." The *General Natural History* is divided into three sections and each one begins with an epigram taken from Pope's anthropological poem.[181]

The notion that biological life was meant for the planet on which it found itself also ran through Kant's later work, although more abstractly expressed. He suggested in the *Critique of Pure Reason* that our terrestrial experiences had limited applicability to aliens, writing, "For we cannot judge whatsoever the ideas of other thinking beings, whether they are bound by the same conditions that limit our ideas and are for us valid in general."[182] Aliens probably had their own way of reasoning and we can approach their existence only via our own experiences, a point that Kant also picked up in 1798, in his *Anthropology from a Pragmatic Point of View*, where he wrote, "In order to put our concepts of rational beings under one opinion, we can only proceed by anthropomorphizing them."[183] When it comes to outer space, humans can only export Man.

Kant's anthropological agenda is the last word in celestial anthropology's liminality and contains the seeds of a radically new philosophical system. After projecting his mind outward and back, Kant concluded that the only way

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178 Dick, *Plurality of Worlds*, Crowe, *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell*.

179 The interest was extensive and ran through his entire corpus. G. Felicitas Munzel, *Kant's Conception of Moral Character: The "Critical" Link of Morality, Anthropology, and Reflective Judgment* (Chicago: University of Chicago Press, 1999), Zammito, *Kant, Herder, and the Birth of Anthropology*.

180 Immanuel Kant, *Schriften Zur Anthropologie Geschichtsphilosophie Politik Und Pädagogik*, ed. Wilhelm Wieschedel, 6 vols., vol. 6, Immanuel Kant: Werke in Sechs Bänden (Darmstadt: Wissenschaftliche Buchgesellschaft, 1998), 688.

181 Kant, *Werkausgabe*, 255, 71, 375. Perhaps Pope really was a metaphysician, after all.

182 Immanuel Kant, *Immanuel Kant Werkausgabe*, ed. Wilhelm Weischedel, 12 vols., vol. 4 (Frankfurt am Main: Suhrkamp Verlag, 1974), 76. Kant touches on this theme later in the text, albeit in a different context, writing, "It could well be, that on some other planet rational beings exist, who could only think out loud—whether awake or dreaming, in society or alone, cannot have any thought without speaking it out loud." (Kant, *Werkausgabe*.)

183 In his *Anthropologie* Kant writes, "Wir können, um unseren Begriffen von vernünftigen Wesen Anschauung unterzulegen, nicht anders verfahren, als sie zu anthropomorphisieren." Johannes Kepler, *Kepler's Somnium: The Dream, or Posthumous Work on Lunar Astronomy*, trans. Edward Rosen (Madison, WI: The University of Wisconsin Press, 1967). Guthke, *The Last Frontier*. He then notes that we are different and must live *within* society.

to understand human life was to limit the analysis to the things to which human beings have direct access, which means experiences from *this* world. This approach is most clearly on display in the *Critique of Pure Reason* (1781) where Kant dedicates a long and complicated section, called the "Antinomy of Pure Reason", to explaining the limits of our reason's ability to understand things beyond its experiential horizon.[184] For Kant, our reason pushes us to understand the universe in terms of a cosmological totality, but this totality is not actually accessible to earth-bound creatures in the way that Copernicus would have presumed. When terrestrial creatures ponder infinite space or the infinity of worlds, they lose their moorings. Put another way, we understand the limits of our sense, when our contemplation of the infinite provokes us into speaking nonsense.[185] Epistemic modesty is one lesson that emerged from celestial anthropology.[186]

Now, we turn to from Kant to his greatest student, Johann Gottfried Herder. Herder's work was also deeply affected by the astronomical themes.[187] Already in 1765, as a student at the University of Königsberg, he wrote an unpublished paper entitled "First Principles of Astronomy", which set out a Newtonian view of the physical universe that he had inherited from his teacher. He also published a series of articles for German journals on scientific topics, including one on Copernicus, in 1776, and four on Isaac Newton, in 1802.[188] The following year, he published a poem "The Stars", which combined the sense for distance articulated by Lambert with the yearning of Kant's celestial anthropology, opening with the lines, "Beautiful starry realm, your worlds unending meadows/Beside myself with rapture, my eye trembles before you."[189] Regardless of all the other influences on his work —and there were many— astronomy permeated the very air that Herder breathed.

Herder's published works are as imposing as those of Kant, running into all sorts of disciplines, including theology, literary criticism and language. In order to trace the significance of astronomy, we will concentrate on the text that most contemporary commentators consider to be his signal contribution

184 Kant, *Werkausgabe*, 399-511.

185 *Ibid*.

186 Epistemic modesty was at the root of the sharp disagreement between the two philosophers over Herder's great work, the *Ideas*. See the originally anonymously published reviews: Immanuel Kant, ""Rezension Zu Johann Gottfried Herder, Ideen Zur Philosophie Der Geschichte Der Menschheit (Erster Teil)"", *Allgemeine Literatur-Zeitung*, no. 4 (1785), ———, ""Rezension Zu Johann Gottfried Herder, Ideen Zur Philosophie Der Geschichte Der Menschheit (Zweiter Teil)"", *Allgemeine Literatur-Zeitung*, no. 271 (1785).

187 On Herder's relationship to eighteenth-century science, see Hugh Barr Nisbet, *Herder and the Philosophy and History of Science* (Cambridge: Modern Humanities Research Association, 1970), Wolfgang Pross, "Herder Und Die Anthropologie Der Aufklärung", in *Johann Gottfried Herder: Werke*, ed. Wolfgang Pross (Munich: Carl Hanser Verlag, 1987).

188 Johann Gottfried Herder, "Etwas Von Nikolaus Kopernikus Leben", *Der Teutsche Merkur* 4 (1776), Herder, "Newtons Teleskop.", ———, "Isaak Newtons Gesetz Der Schwere.", ———, "Newtons Theorie Des Lichts Und Der Farben.", ———, "Newton Und Keppler."

189 Johann Gottfried Herder, "Sterne", *Adrastea* 6 (1803).

to the anthropological debate, *Ideas on the Philosophy of the History of Mankind*, an unfinished multi-volume work that was published between 1784 and 1791.[190]

The agenda setting nature of astronomical thought is immediately on display in this work. The first chapter is entitled, "Our Earth is one Star among Stars."[191] The first sentence reads, "Our philosophy of the history of humanity must start with the Heavens, if it is to be considered worthy of the name."[192] By the end of the first paragraph, Herder has expressly cited the work of Copernicus, Kepler, Newton, Huygens and Kant as examples of astronomy's contributions to the understanding of humanity.[193] From there he spends the rest of the Book One (he completed twenty) thinking his way back down to our solar system, our globe and then its geography and history.

Herder began his philosophy of the history of humanity by re-creating the world on which we live. In the rest of the text he followed the same plan that Wolff and Buffon used, emphasizing that we are part of a web of biological life that extends around our planet. Books Two and Three, taken together, begin with plants and end with animals and human beings.[194] Books Four and Five trace the emergence of the human spirit (in the sense of the German *Geist*), arguing that the human being is a rational creature that is designed to believe in God and is only a small part of a larger process of development that suffuses the entire universe.[195] The second part of the *Ideas*, which runs from Book Six to Book Twenty, offers a tutorial in human interaction with the globe, discussing the organization of tribal peoples and their practices, before turning to documented history, wherein are considered all regions of the globe and every ancient civilization of which Europeans then had knowledge.[196] Five more books were planned, but never completed. These would have been dedicated exclusively to European history, with one devoted to the world historical significance of the Reformation.

Looking back over the territory that Herder covers, we see can the agenda of celestial anthropology writ large, as the new cosmology runs through the entire work. In the second book of the *Ideas*, for example, Herder takes the same position above our planet as did Edward Young in *Night Thoughts*, contemplating it from orbit, and concluding, as did Isaac Watts in *The First Principles of Astronomy* that this planet is designed for human life.[197] Herder even entitles one chapter in the Tenth Book, "Our Earth is a Self-Formed

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190 ———, *Herders Werke in Fünf Bänden*, ed. Regine Otto, 5 ed., 5 vols., vol. 4 (Berlin: Hermann Duncker, 1978).
191 *Ibid*., 17.
192 *Ibid*.
193 Dick, *Plurality of Worlds*, Michael J. Crowe, *The Extraterrestrial Life Debate, 1750-1900* (Mineola, NY: Dover Publications, Inc., 1999).
194 Herder, *Werke 4:* , 21-35.
195 *Ibid*., 36-94.
196 *Ibid*., 97-462.
197 *Ibid*., 218.

Earth [Designed] for its Living Creation."[198] The sense that we are from this Earth is, however, balanced against our place within the larger universe created by God, as Herder also wrote, "Wherever and whoever I may be, …[I am] a being in the unforeseeable Harmony of one of God's worlds."[199] By the late eighteenth century, the human being and all of human history could not be understood without reference to the stars.

Alexander von Humboldt (1769-1859) was the last of the celestial anthropologists. Born in Prussia, he studied in the Kingdom of Hannover, matriculating in 1787 at the new University of Göttingen, which was becoming the model for the modern research university. Living in this part of Germany was crucial to the development of Humboldt's mental universe. Although a small town, Göttingen offered an unusually rich and densely interconnected intellectual environment.[200] From 1751 on, in addition to its university, it had both an observatory and an academy of sciences, thus recapitulating many of the key themes of the seventeenth century. On the one hand, its observatory had hosted one of the eighteenth century's most important astronomers, Tobias Mayer (1723-1762), thus inaugurating a scholarly reputation that ran into the nineteenth century.[201] On the other hand, it was also a center of anthropological research, thanks to the presence on the university faculty of Johann Friedrich Blumenbach, who was one of Humboldt's mentors. In addition, the nearby city of Kassel was another center of anthropological research, thanks to the founding in 1745 of a scientific society called the *Collegium Carolinum*. The naturalist Georg Forster worked at this society in the 1780s, during which time he also mentored the young Humboldt.

Humboldt was a product of an intellectual environment that actively cultivated knowledge of both the stars and of human beings. It is not coincidental, therefore, that in 1845, he began to publish the last word in celestial anthropology, his five-volume *Cosmos*. Taken together, the five volumes, which were published over the next seventeen years, collated and summarized every aspect of eighteenth-century science against the backdrop of the known universe. Consider these words from the introduction:

> Beginning with the depths of space and the regions of remotest nebulae, we will gradually descend through the starry zone to which our solar system belongs, to our own terrestrial spheroid, circled by air and ocean, there to direct our attention to its form, temperature, and magnetic tension, and to consider the fullness of organic life unfolding itself upon its surface beneath

198 *Ibid*., 218-21.
199 *Ibid*., 20.
200 Nicolaas A. Rupke, *Göttingen and the Development of the Natural Sciences* (Göttingen: Wallstein, 2002). See also Hammermayer, "Akademiebewegung Und Wissenschaftsorganisation Während Der Zweiten Hälfte Des 18. Jahrhunderts."
201 Eric G. Forbes, "Tobias Mayer's Contributions to Observational Astronomy", *Journal for the History of Astronomy* 11 (1980).

> the vivifying influence of light. In this manner a picture of the world may, with a few strokes, be made to include the realms of infinity no less than the minute microscopic animal and vegetable organisms which exist in standing waters and on the weather-beaten surface of our rocks.[202]

No more succinct definition of celestial anthropology could be written. An overview of the entire text will highlight the universal nature of Humboldt's vision. Humboldt follows a plan reminiscent of both Chappuzeau and Buffon, moving inward from the limits of the universe, and only discussing the human being at the end of the first volume —and then in all of twelve pages, wherein he covers the following topics: "Universality of Animal Life", "Geography of Plants and Animals", "Floras of Different Countries", "Man", "Races", "Language."[203] Once again, anthropology begins with the universe and ends with Man.

Volume two follows with a history of Western Civilization much like the one offered by Herder, but is told with reference to the Western tradition of studying the natural world.[204] Here Humboldt highlights the dual revolutions of Columbus and Copernicus, covering the Age of Reconnaissance and the astronomical revolution that runs through Kepler to Newton. The same "outside in" rhythm extends through volumes three and four. Volume three summarizes all recent astronomical knowledge and explains the universe's physical structure, before considering our solar system.[205] In volume four Humboldt considers each of the planets within our system as an individual space.[206] Volume five then takes celestial anthropology to new depths, describing the Earth's geology, which was a topic that, until then, anthropologists had not explored.[207] This subterranean perspective is the ultimate end of liminality, as after five volumes, Humboldt moved from the margins of the universe all the way to the Earth's core. For Alexander von Humboldt, celestial anthropology ended in geology.

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202 Alexander von Humboldt, *Kosmos: Entwurf Einer Physischen Weltbeschreibung*, 5 vols., vol. 1 (Stutgart: J. G. Cotta'scher Verlag, 1845).

203 *Ibid*., 374-86. The list of topics is taken from the English translation. ———, *Cosmos: A Sketch of a Physical Description of the Universe*, trans. E. C. Otté, vol. 1, Foundations of Natural History (Baltimore, MD: Johns Hopkins Press, 1997), 14.

204 Alexander von Humboldt, *Kosmos: Entwurf Einer Physischen Weltbeschreibung* 5vols., vol. 2 (Stuttgart: J. G. Cotta'scher Verlag, 1847).

205 ———, *Kosmos: Entwurf Einer Physichen Weltbeschreibung*, 5 vols., vol. 3 (Stuttgart: J. G. Cotta'scher Verlag, 1850).

206 ———, *Kosmos: Entwurf Einer Physichen Weltbeschreibung*, 5 vols., vol. 4 (Stuttgart: J. G. Cotta'scher Verlag, 1858).

207 ———, *Kosmos: Entwurf Einer Physischen Weltbeschreibung*, 5 vols., vol. 5 (Stuttgart: J. G. Cotta'scher Verlag, 1862).

Part VII

If Man is a cosmological construct then the Plurality of Worlds debate is an essential component of anthropological discussion. The debate has an ancient pedigree, dating back to the early Greek atomists, including Leucippus and Democritus (both 5th century B.C.).[208] It then extended Roman times, in the work of Plutarch, Lucretius, Cicero and Diogenes Laertius, before disappearing in the rubble of the Roman Empire. Much like the works of Euclid and Ptolemy, atomistic texts were rediscovered during the Renaissance and their translation and republication influenced great minds, such as Leonardo DaVinci (1452-1519) and Nicholas of Cusa (1401-1464). On astronomical matters, their influence was most significant, however, in the sixteenth and seventeenth centuries, when Johannes Kepler, Pierre Gassendi (1592-1655) and Henry More (1614-1687) came across them. Kepler even translated Plutarch's *De facie in orbe lunae* ("On the Face in the Moon"), which was a Platonic dialogue that speculated on whether the Moon could host life.

Steven Dick has argued persuasively that the Plurality of Worlds' history can be understood in terms of the return of Democritean atomism to European philosophy.[209] Democritus' notion that matter was composed of atoms had a leavening effect on the Aristotelian-Ptolemaic system, when the latter was still dominant in Europe. However correct, this point is incomplete, since atomistic texts returned at roughly the same time as the spatial texts that we have already discussed. For example, Lucretius' atomistic poem *De rerum naturae* ("On Nature") was re-published in 1417 by the humanist Gian Francesco Poggio Bracciolini (1380-1459), eleven years after Giacomo Angelo da Scarperia issued the first Latin translation of Ptolemy's *Geographia*. Ptolemy's *Almagest* was also summarized in Regiomontaus' *Epitome* of 1462 and was published in a complete translation by George of Trebizond in 1481. In the following year, the first full translation of Euclid's *Elements* into Latin appeared in Venice. The Renaissance rediscovery of space was, thus, contemporary to the rediscovery of atomism and, based on what we have argued above, at least equal in importance to this other current.

Given what we have said about space, it becomes clear that the early-modern Plurality of Worlds debate was an inherently anthropological discussion. Along these lines, it is suggestive that Kepler, one of history's most prominent Copernicans (and translator of Plutarch), wrote a speculative text called *Somnium* that argued that intelligent beings lived on the Moon.[210] Published posthumously in 1634, this text described a journey to the Moon by "Duracotus", a student of Tycho Brahe, and expressly imagined how the Earth

208 On the history of this debate, see Dick, *Plurality of Worlds*.
209 *Ibid*.
210 Kepler, *Kepler's Somnium: The Dream, or Posthumous Work on Lunar Astronomy*.

would appear from this radically different vantage point.[211] *Somnium* reveals how the new aesthetic of space encouraged imaginary journeys between spaces that the viewer would never experience, putting both writer and reader in a position that encouraged critical reflection on humanity.

The use of extraterrestrial space as a foil for changing our view of the terrestrial did not end with Kepler. A similar approach is on display in two other texts from the same century: John Wilkin's *The Discovery of a World in the Moon* (1638) and Cyrano de Bergerac's *Other World, or, States and Empires of the Moon* (1657). The former is a defense of the Copernican world system that argues that the Moon is also a planet on which life may be found. (In 1712, this text was also translated into German, where the title became, not coincidentally, *Copernicus Defended* and the translator was none other than the astronomer and globe maker Johann Gabriel Doppelmayr.)[212] The latter text, in addition to describing the first space rocket, tells of Cyrano's imaginary trip to the Moon, during which he discovers that it is a paradise and criticizes explicitly some of the sillier customs practiced by humans, such as the wearing of swords in public.

From a literary perspective, texts such those of Wilkins and Cyrano can be understood as extensions of critical that extended through the Renaissance.[213] For instance, Cyrano's cultural criticism was very likely influenced by the cultural inversion practiced by both Rabelais and Montaigne. If we look forward in time, however, we can connect these texts to the rise of celestial anthropology by understanding them with reference to the two Plurality of Worlds texts that we have already discussed, Fontenelle's *Conversations On the Plurality of Worlds* (1686) and Huygens' *Cosmotheoros* (1697). During the period when astronomy and anthropology were just beginning to converge the Plurality of Worlds debate was raging, a crossover whose significance has yet to be understood fully. And as we have seen in Kant's work above, the notion of extraterrestrial life won the day, precisely because the new astronomy allowed people to imagine vividly spaces and places in which life could be put, thus allowing any person to rethink the status of human beings.

The Plurality of Worlds debate extended well into the eighteenth century.[214] Having discussed Kant above, we will consider below two

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211 On *Somnium*'s significance for literary history, see Guthke, *The Last Frontier*, Karl Guthke, "Nightmare and Utopia: Extraterrestrial Worlds from Galileo to Goethe", *Early Science and Medicine* 8, no. 3 (2003). For discussions of the plurality of worlds debate, of which *Somnium* must be reckoned a part, see Dick, *Plurality of Worlds*, Crowe, *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell*, Patricia Fara, "Heavenly Bodies: Newtonianism, Natural Theology and the Plurality of Worlds Debate in the Eighteenth Century", *Journal for the History of Astronomy* 35 (2004), William C. Heffernan, "The Singularity of Our Inhabited World: William Whewell and A. R. Wallace in Dissent", *Journal of the History of ideas* 39, no. 1 (1978).

212 John Wilkins, *The Discovery of a World in the Moon, or, a Discourse Tending to Prove That 'Tis Probable There May Be Another Habitable World in That Planet* (London: Michael Sparke and Edward Forrest, 1638).

213 Frank E. Manuel and Fritzie P. Manuel, *Utopian Thought in the Western World* (Cambridge, MA: Belknap Press, 1979).

214 Crowe, *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell.*

neglected eighteenth-century texts that, nonetheless, reveal how significant the new astronomy was to the exportation of intelligence to other planets. First, we note a text almost wholly ignored by the scholars of anthropology, Emmanuel Swedenborg's *De telluribus planetarum in mundo nostro solari quae vocantur planetae…* (1758) ("*Of the Earthly Globes in our Solar System, Which Are Called Planets…"*)[215] In this text Swedenborg populates every planet in our solar system (and those of every other system) with intelligent beings. Unlike Huygens or Fontenelle, however, he does not base his support for extraterrestrials on geometry or analogical reasoning. Instead, he argues that the souls of the dead from each planet speak to him, which allows him to offer a vivid picture of the inhabitants of each planet.[216]

After informing the reader of his unique abilities, Swedenborg analyzed the life forms on every planet, beginning with Mercury, Jupiter, Mars, Saturn, Venus and the Moon, before speculating even further on beings from other systems.[217] In addition, according to the text, angels also guided Swedenborg to five different Earths in the realm outside our solar system, where the spirits informed him of the inhabitants there and their respective natures. Obviously, this specific method of analysis lay outside the mainstream of celestial anthropology. Nonetheless, the spatial reference points are the same, and it is significant that Swedenborg treated as a place for life (physical or spiritual) each planet not only in our solar system but also those being imagined as existing in other systems. The spatial aesthetic that dominated celestial anthropology from Huygens to Humboldt is, thus, clearly on display here. More important, perhaps, is that Swedenborg also expressly notes that the people living on the other Earths can, in turn, talk to the spirits that envelop our planet, which lets extraterrestrials imagine who we are, too. We have come a long way from Pascal's gripping fear of being ignored. In Swedenborg's thought homogenous and reflexive Copernican space unifies the spiritual realm. Humans can talk to the spirits from extraterrestrial realms and the inhabitants of these realms can also talk to our spirits. Outer space became the ultimate playground for the dreams of the Spirit-Seer.

Swedenborg is an extreme example of the new spatial aesthetic's reach. Nonetheless, other writers used the same space to tell their own tales. In 1752, for example, Voltaire published *Micromégas*, a mordant story, in which a traveler from near the star Sirius comes to our solar system and meets up with a friend from Saturn, before both of them head to Earth, where they discover that human beings are pathetic.[218] Voltaire's text is not to be taken

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[215] Emmanuel Swedenborg, *De Telluribus Planetarum in Mundo Nostro Solari Quae Vocantur Planetae Et De Telluribus in Coelo Astrifero Deque Illarum Incolis, Tum De Spiritibus Et Angelis Ibi Ex Auditis Et Visis* (London1758).
[216] *Ibid*., 4.
[217] *Ibid*., 6, 18, 34, 41, 43, 45, 49.
[218] Voltaire, *Élémens de la Philosophie de Neuton: Mis à las portée de tout le Monde* (Amsterdam: Jacques Desbordes, 1738), ———, *Le Micromégas de Mr. de Voltaire avec une Histoire des Croisades & un Nouveau Plan de l'Esprit Humain*

seriously as science; it is purely a literary invention and borrows heavily from Jonathan Swift's *Gulliver's Travels*, which ties it to a very terrestrial travel literature. *Micromégas* does represent well, however, the growing reach of astronomical thought, as his aliens do not hail from the Moon or the other planets in our system, but from deep space. As Goethe noted, astronomy was progressing ever further into infinity —and celestial anthropological thought went along with it.

Voltaire is particularly significant in this context, because he was a popularizer of Newtonian science and an anthropologist.[219] His way of associating anthropological perspectives with astronomical themes did not, therefore, occur by chance, and he was deeply influenced by intellectual developments in Paris, which was both a center of anthropological thought and one of the most important centers of astronomical research in Europe.[220] Indeed, the frontispiece to his popular Newtonian work, *The Philosophy of Newton* (1738) (Figure 6) cements for us the spatial realm in which celestial anthropology developed. At the top left is God the geometer, presiding over the celestial sphere (and bearing a remarkable resemblance to Isaac Newton). At the bottom is a terrestrial sphere in a scholar's study accompanied by the scholar himself who also happens to be bent over in contemplation of the things that he cannot actually see. A compressed representation of an age, the image reminds us that natural knowledge had to be distilled and distributed through the patient work of an army of scholars who had joined the ranks of Europe's astronomical program. God may have created the universe, but a broad array of writers made its spaces the common heritage of Man.

(London: J. Robinson, 1752), Guthke, *The Last Frontier*. I am indebted to Prof. Oscar Kenshur of Indiana University at Bloomington for recommending *Micromégas* to me.

219 Duchet, *Anthropologie Et Histoire*, Wolff, *Inventing Eastern Europe*.

220 The Paris observatory, founded in 1667, rapidly became famous around Europe and across France under the leadership of the Cassini family of astronomers. Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803*.

Conclusions

Celestial anthropology and anthropology parted ways in the wake of Alexander von Humboldt's death. During the second half of the nineteenth century, those scholars that are now part of the anthropological canon reduced the field's conceptual boundaries. Anthropologists from all four of the fields noted above could be included, but we will concentrate on one whose historical significance for cultural anthropology cannot be overestimated, Franz Boas (1858-1942).

Boas is the undisputed founder of contemporary American cultural anthropology.[221] He came to the United States from Germany in the late nineteenth century, finally settling in 1896 at Columbia University, where he founded America's first graduate program in Anthropology. It may, thus, be surprising to note that Boas did not study anthropology, but philosophy and physics, the latter discipline being the one in which he earned his doctorate at the University of Kiel, in 1881. Boas was, therefore, steeped in the scientific methods that had produced the spatial world in which celestial anthropology took shape. He was, however, also extremely well informed on anthropological currents in German thought, thanks to his philosophical studies, which began at Heidelberg and continued in Bonn. It was while studying philosophy that he read, the anthropological works of Kant, Herder and Wilhelm von Humboldt (1767-1835), Alexander's elder brother. Reading Herder and the elder Humboldt, in particular, convinced him of the significance of language to the development of human culture.

Boas' anthropology rested, thus, on the twin pillars of eighteenth-century anthropological thought and spatial science. The best evidence we have of this is the publication in 1885 of two seminal articles. The more famous of the two is, "The Principles of Ethnological Classification", (1887), which laid down many principles of modern cultural anthropology. Boas wrote that ethnological phenomena are:

> …the result of the physical character of men, and of its development under the influence of the surroundings: therefore two problems must be studied for attaining scientific results. The preliminary study is that of the surroundings: the final aim of the researches is the knowledge of the laws and history of the development of the physiological and psychological character of mankind. 'Surroundings' are the physical conditions of the country, and the sociological phenomena, i.e. the relation of man to man.[222]

[221] Cole, *Franz Boas*, Stocking, ed. *Volksgeist*, George W. Stocking, ed. *The Shaping of American Anthropology, 1883-1911: A Franz Boas Reader* (New York: Basic Books,1974).
[222] Stocking, ed. *Franz Boas Reader*, 63-64.

In his most fundamental meditations on the nature of anthropology Boas began with terrestrial space, setting up "surroundings" as the backdrop for the emergence of culture. Significantly, Boas published another spatial article that same year, entitled, "The Study of Geography", in which he laid down the principles for understanding geographic space.[223] This article was extremely influential in the geographic discipline and highlights for us, how space and Man were already inseparable when the first sounding of the modern anthropological discipline were heard.

These two essays reveal the profound spatial underpinnings of Boas' thought. What remains to be explained is the absence of the celestial context. Boas' elision of astronomy from anthropology represents the waning of the spatial turn that began with Copernicus. More than five hundred years after the publication of *De revolutionibus* and two hundred years after *Principia Mathematica* appeared, the heliocentric universe and the spatial aesthetic that went along with it no longer needed expressions of allegiance —and certainly not from a man who 0.66had taken a doctorate in physics. Eighteenth-century astronomy had effectively erased all doubt about the heliocentric universe and the theory of gravity. In 1758, the return of Comet Halley, which had been predicted by Sir Edmund Halley on Newtonian principles, confirmed the basic correctness of Newton's theories.[224] That the first person to observe this comet's return was Johann Georg Palitzsch, a well-off Saxon peasant farmer who was also an amateur astronomer, only underscores the discipline's cultural reach.[225] In addition, the discovery in 1781 by the self-taught astronomer William Herschel of our solar system's seventh planet, Uranus, only increased astronomy's already tremendous prestige.[226] Not only had the discipline moved the earth, it had now changed the skies. In this context we should note that the eighteenth century witnessed two anniversaries whose observance embedded astronomy further in the public mind, the three hundredth anniversary of Copernicus' birth in 1476 and the two hundredth anniversary of his death in 1543, both of which required commemoration in print —and one of those who published a memorial piece was none other than Johann Gottfried Herder.[227] Hence, Boas stood at the end of an historical current that had simply settled the matter of the universe's design (and our position within it). For that reason, he could

223 Saul Benison, "Geography and the Early Career of Franz Boas", *American Anthropologist* 51, no. 3 (1949), Roger T. Trindell, "Franz Boas and American Geography", *The Professional Geographer* 21, no. 5 (1969).
224 Schaffer, "Authorized Prophets."
225 The astronomer in question was named Johann Georg Palitzsch (1723-1788). George W. E. Beekman, "The Farmer Astronomer", *Sky and Telescope* 79 (1990).
226 Michael A. Hoskin, *William Herschel and the Construction of the Heavens* (New York: W. W. Norton & Co., 1964), Simon Schaffer, "Herschel in Bedlam: Natural History and Stellar Astronomy", *The British Journal for the History of Science* 13, no. 3 (1980), ———, "Uranus and the Establishment of Herschel's Astronomy", *Journal for the History of Astronomy* 12 (1981), Michael A. Hoskin, *The Herschel Partnership: As Viewed by Caroline* (Cambridge: Science History Publications, 2003).
227 Herder, "Etwas Von Nikolaus Kopernikus Leben."

begin his study of Man without reference to the celestial backdrop that had been so important up through Alexander von Humboldt.

This does not mean, however, that Boas' emphasis on the study of culture had no connection to astronomy. If we consider his approach more narrowly, we can understand the cultural emphasis in Boas' work as an extension of the celestial context sketched by von Humboldt's *Cosmos*; the former picked up where the latter left off. We noted earlier that Humboldt ended the first volume of *Cosmos* with a few pages on "Man", "Races" and "Language." The younger Humboldt wrote these sections under the influence of both Herder and Wilhelm von Humboldt, Alexander's elder brother.[228] In addition to being an important anthropologist and writer, Herder was one of the eighteenth century's most important theorists of language, eclipsed perhaps only by Humboldt.[229]

Consistent with these influences, Boas' anthropological work is characterized by an overriding interest in language, as a great many of his works emphasize analyzing culture through language. The earliest works that Boas published based on fieldwork done in the western United States concentrated in the study of Native American language and culture.[230] This connection between language and culture then extended through the end of his life, as one of his final works, published in 1940, bears the title, *Race, Language and Culture*, which mimics very closely the conceptual progression at the end of Alexander von Humboldt's great work. In this sense, Boas was celestial anthropology's direct heir, if a forgetful one. As a result of what amounts to disciplinary amnesia, Boas sent American anthropology in a direction that soon made it wholly independent of celestial anthropology and its spatial agenda. His intellectual heirs in the first half of the twentieth century constructed a new discipline that worked without reference to the stars. These heirs then constructed a canon that emphasized the discovery of culture as the key element in the emergence of their discipline. Unaware that Man was a cosmological construct, they acted as if culture were independent of the stars, too.

Although celestial anthropology and cultural anthropology reached a fork in the road, the former still holds sway over other important intellectual

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228 The elder Humboldt also wrote a plan for comparative anthropology that was heavily influenced by Blumenbach. See, Wilhelm von Humboldt, "Plan Einer Vergleichenden Anthropologie", in *Wilhelm Von Humboldts Gesammelte Schriften*, ed. Albert Leitzmann (Berlin: B. Behr's Verlag, 1903), 377-410. More generally, see Peter Hanns Reill, "Science and the Construction of the Cultural Sciences in Late Enlightenment Germany: The Case of Wilhelm Von Humboldt", *History and Theory* 33, no. 3 (1994).

229 On Herder and language, see Anthony J. La Vopa, "Herder's Publikum: Language, Print, and Sociability in Eighteenth-Century Germany", *Eighteenth-Century Studies* 29, no. 1 (1995). On Humboldt, Christina M. Sauter, *Wilhelm Von Humboldt Und Die Deutsche Aufklärung* (Berlin: Duncker & Humblot, 1989), Paul Sweet, "Young Wilhelm Von Humboldt's Writings (1789-93) Reconsidered", *Journal of the History of Ideas* 34, no. 3 (1973).

230 Franz Boas, *Handbook of American Indian Languages*, 2 vols. (Washington: Government Print Office, 1911). See also ———, *The Mind of Primitive Man: A Course of Lectures Delivered before the Lowell Institute, Boston, Mass., and the National University of Mexico, 1910-1911* (New York: The Macmillan company, 1911).

realms. We will consider two, theology and science writing. We will begin with theology. In 1984, Helmut Thielicke (1908-1986), one of the most important German Protestant theologians of the last century, published his memoirs under the title *A Guest on Beautiful Star*. The title alone displays not only the sentiments Herder had expressed exactly two centuries before but also the homogeneous, simultaneous and reflexive space that emerged in the fifteenth century.[231] To be merely a guest on a beautiful star suggests that there can be other guests on other ones, with each being living life in each place and, perhaps, taking note of our star along the way. What had made Pascal fearful gave the Thielicke comfort. The desire to understand Man's relationship to God via outer space also runs through the work of another Protestant theologian, Wolfhart Pannenberg (1928-). His anthropology comes straight from Herder's celestial playbook. He wrote:

> It is significant that Johann Gottfried Herder, a theologian, stands at the origins of modern anthropology. In his *Ideas on the Philosophy of the History of Humanity* (1784) Herder described the human being as the first freedman of Creation.[232]

Pannenberg's reflections on the nature of Man returned repeatedly to the subject of outer space.[233]

This celestial approach to God and Man also included Catholic thinkers. In 1884, Joseph Pohle, a professor of theology at the Catholic University in Washington D.C., published *Celestial Worlds and their Residents*, which explored what the plurality of worlds meant for human beings and their view of God.[234] It was very popular in the author's native Germany, where it went through six editions. Another example is Karl Rahner, a Jesuit who spent most of his professional life in Jesuit colleges.[235] His most important works were published in the 1960s and were often characterized by reflections on the significance of outer space for the human being's understanding of not only God but also Man.[236] Hence, across the Christian religious spectrum, we find the same determination to understand the anthropological implications of all the new spaces that astronomer had taught the world to imagine.

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231 Helmut Thielicke, *Zu Gast Auf Einem Schönen Stern: Erinnerungen Aus Meinem Leben* (Giessen: Brunnen Verlag, 2007).

232 Pannenberg, *Was Ist Der Mensch?* , 12.

233 Wolfhart Pannenberg, *Theology and the Philosophy of Science* (Philadelphia, PA: Westminster Press, 1976), ———, *Toward a Theology of Nature: Essays on Science and Faith* (Louisville, KY1993). Max Scheler's work heavily influenced Pannenberg. See Max Scheler, *Die Stellung Des Menschen Im Kosmos* (München: Nymphenburger Verlagshandlung, 1947). On Scheler, see Manfred S. Frings, *The Mind of Max Scheler: The First Comprehensive Guide Based on the Complete Works* (Milwaukee1997).

234 Joseph Pohle, *Die Sternenwelten Und Ihre Bewohner* (Cologne: Bachem, 1889).

235 Karen Kilby, *Karl Rahner: Theology and Philosophy* (London: Routledge, 2004).

236 Karl Rahner, *Schriften Zur Theologie*, 16 vols., vol. 15 (Einsiedeln: Benziger, 1962), ———, "Sternenbewohner: Theologisch," in *Lexikon Fur Theologie Und Kirche*, ed. Michael Buchberger, Josef Höfer, and Karl Rahner (Freiburg: Herder, 1964).

With respect to science writing, celestial anthropology had profound effects on two genres, science fiction and popular science. The examples in science fiction are too numerous to name, although it is testimony to the enduring significance of early-modern astronomy's construction of outer space the phrase "Beam me up" and the concept "the dark Side" are instantly recognizable in the course of casual conversation. Of course, science fiction's significance goes beyond the spread of pop culture and extends into anthropological thought. Particularly significant, in this context, is the work of Stanislaw Lem, whose essays and books have repeatedly explored the implications of the space age for our understanding of Man.[237]
The anthropological yearnings inspired by celestial contemplation do not end with science fiction any more than Kepler's *Somnium* represents the limit of that German astronomer's interest in Man. One of the most important contemporary examples of the mixture of astronomical knowledge with anthropological themes is Carl Sagan's *Cosmos* (1980). Beginning as an oft-watched PBS television series and ending in a best-seller, Sagan's *Cosmos* expressly mixed astronomy and anthropology. Consider these words from the introduction:

> The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home. In a cosmic perspective, most human concerns seem insignificant, even petty. And yet our species is young and curious and brave and shows much promise. In the last few millenia we have made the most astonishing and unexpected discoveries about the Cosmos and our place within it, explorations that are exhilarating to consider.[238]

Sagan's comments frame all the insights gathered by Europeans about "Man" and the cosmos since the middle of the sixteenth century. By mentioning the immensity of space he echoes the insights of Lambert, the wonder of Young and the anthropological impetus of Kant, in addition to underscoring science constructed the world in which both "Man" and the contemporary scholars of his emergence live. One of the illustrations in Sagan's book shows the famous photograph "Earth Rising", (Figure 7), which was taken from the Moon on December 24, 1968, by the crew of the Apollo 8 mission. Sagan's caption reads, "The Earth from the Moon: The view that Kepler dreamed of."[239] Completing the historical circle, Sagan reminds us that there is no anthropology without astronomy; there is no Man without the Cosmos.

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[237] See especially the essay "Back to Earth", in Stanislaw Lem, *Summa Technologiae*, trans. Friedrich Griese, Second ed. (Frankfurt am Main: Insel Verlag, 1978), 133-257. Patrick Parrinder, ed. *Learning from Other Worlds: Estrangement, Cognition, and the Politics of Science Fiction and Utopia* (Liverpool: Liverpool University Press,2000), 178-92, George E. Slusser and Eric S. Rabkin, eds., *Aliens: The Anthropology of Science Fiction*, Alternatives (Carbondale, IL: Southern Illinois University Press,1987).
[238] Carl Sagan, *Cosmos* (New York: Ballantine Books, 1980), 1.
[239] *Ibid*., unpaginated.

FIGURE 1. THE COPERNICAN COSMOLOGY (1543)

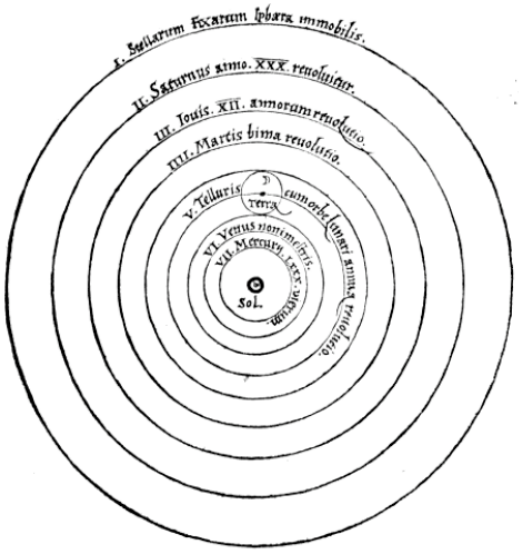

FIGURE 2. POCKET TERRESTRIAL AND CELESTIAL SPHERES (18TH CENTURY)
(Image removed due to copyright restictions)

FIGURE 3. MÜLLER, *ANWEISUNG V. 1* (1791)
(Image removed due to copyright restictions)

FIGURE 4. MÜLLER, *ANWEISUNG, V.2* (1792)
(Image removed due to copyright restictions)

FIGURE 5. *NOUVEL ATLAS DES ENFANS* (1776)
(Image removed due to copyright restictions)

FIGURE 6: VOLTAIRE, *LA PHILOSOPHIE DE NEUTON* (1738)

FIGURE 7. "EARTH RISING"

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