

# **Rethinking Matter and Time**

Curricular Materials Prepared by  
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## **Index:**

- *Journey of the Universe Book*: Chapter 10: Rethinking Matter and Time.
- *Journey of the Universe Film*: N/A.
- *Journey of the Universe Conversations*: N/A.

## **Scientific Summary:**

“Deterministic realism” is the name that we give to a particular worldview that understands reality to be composed of inert, mathematically predictable matter. Originating in the dramatic scientific insights of sixteenth and seventeenth century thinkers, deterministic realism can be thought of as having three core presuppositions: First, it assumes that all things in the universe are made up of tiny bits of inert matter. Second, these bits of matter are assumed to be entirely material and devoid of subjectivity. And, third, it postulates that the movement and composition of these bits of matter can be measured and predicted through mathematical laws. While this worldview has allowed us to make advances in science and technology, it is also a way of viewing the world that allows us to act in destructive ways towards the environment and other living beings.

A number of history’s great scientists fall within the tradition of deterministic realism. Galileo, one of the first scientists to think in this manner, formulated the first mathematical expressions for the motion of falling matter. Isaac Newton continued in this tradition when he used observation and mathematics to accurately predict the motion of the planets revolving around the sun. His publication of *Principia Mathematica Philosophiae Naturalis* in 1687 was a groundbreaking moment in deterministic realism. Contained within it were several of Newton’s well-known observations such as his laws of motion, his law of universal gravitation, and much of what would later be considered the foundation of classical mechanics.

It was not until the twentieth century that scientists began to rediscover that matter was more than just inert “stuff.” Whereas sixteenth and seventeenth century thinkers such as Rene Descartes and Francis Bacon viewed the world as a machine run by natural laws, twentieth century chemists such as Ilya Prigogine discovered that even chemical molecules have the capacity for intrinsic self-organizing. He discovered that trillions of molecules could organize themselves into complex patterns and that they could do so without the instructive patterns of DNA or the organizing power of the animal mind.

In addition to rethinking matter as subjective and as more than inert “stuff,” scientists are also beginning to come to new understandings of time. One way to view time differently is to view the progression of time as a measure of the creative emergence of the universe. James Hutton and Charles Lyell were the first to recognize that the Earth was part of a multi-billion year process of geological development. Another nineteenth century thinker, Charles Darwin, is well known for his descriptions of the vast depths of evolutionary time. Later, in the twentieth century, Hubble and Einstein extended this epoch-oriented view of history to the emergence and development of the universe itself.

### **Discussion Questions:**

1. As you rethink matter and time, reflect upon what it means to you to live in cosmological time. How is thinking like this different than your previous understanding of time? What implications does it have for your understanding of yourself and your sense of your relation to the world around you?
2. Take an image, scene, or paragraph from *The Journey of the Universe* film, book, or *Conversations* that you feel conveys an important idea in regards to matter and time. Using an appropriate medium (i.e. prose, poetry, dance, painting, music, the spoken word, etc.), reformulate and express this idea in your own way. After doing so, reflect on how that helped you to better understand matter and time.
3. It might be said that the average person lives his or her life in a way that is consistent with the assumptions of deterministic realism. How might reformulating our notions of matter and time cause us to make decisions differently or to value things like rocks and trees in new and unfamiliar ways? What might some of the advantages be of thinking in such a way? What are the disadvantages?

### **Online Resources:**

- For a better understanding of Big History, there is no better place to start than the [Big History Project](#). An immensely useful website, they provide a number of useful guidelines and resources such as [course themes](#), [timelines](#), and a [syllabus](#).
- Finding a reliable encyclopedia online can be difficult. One reputable – and free – online resource that educators might find useful is the [Stanford Encyclopedia of Philosophy](#). Entries include articles on Newton’s [Principia Mathematica Philosophiae Naturalis](#), differing views of [space and motion](#), and one on Einstein’s theory of [General Relativity](#).
- A number of scientific authors have reached wide audiences by writing about matter, space, and time. Try this article on the [beginning of time by Stephen Hawking](#) or this [New York Times article on time by Brian Greene](#).
- The [TED](#) series can be an excellent source of information from top scientists. This talk by [David Christian](#), author of *Maps of Time*, challenges and revises how we look at the history and development of life in relation to a broader cosmic timeline.

- Interested in Ilya Prigogine? Watch this video of him talking about [complexity](#) or read a copy of his [Nobel lecture](#) given in 1977.

### **Print Resources:**

- [Journey of the Universe Bibliography](#).
- [Science Bibliography from the Yale Forum on Religion and Ecology](#).

### **Select Bibliography:**

- Baaquie, Belal, and Frederick Willeboordse. *Exploring Integrated Science*. Boca Raton: CRC Press, 2010.
- Baggott, Jim. *Beyond Measure: Modern Physics, Philosophy and the Meaning of Quantum Theory*. Oxford: Oxford University Press, 2004.
- Barlow, Connie, ed. *Evolution Extended: Biological Debates on the Meaning of Life*. Cambridge, MA: MIT Press, 1994.
- Barrow, John, Simon Conway Morris, Stephen Freeland, and Charles Harper, eds. *Fitness of the Cosmos for Life: Biochemistry and Fine-Tuning*. Cambridge: Cambridge University Press, 2007.
- Beinhocker, Eric. *The Origin of Wealth: Evolution, Complexity, and the Radical Remaking of Economics*. Boston: Harvard Business School Press, 2006.
- Bergson, Henri. *Creative Evolution*. Westport, CT: Greenwood Press, 1975.
- Bird, Richard J. *Chaos and Life: Complexity and Order in Evolution and Thought*. New York: Columbia University Press, 2003.
- Bokulich, Alisa. *Reexamining the Quantum: Classical Relation*. Cambridge: Cambridge University Press, 2008.
- Bruteau, Beatrice. *God's Ecstasy: The Creation of a Self-Creating World*. New York: Crossroad, 1997.
- Capra, Fritjof. *The Hidden Connections: Integrating the Biological, Cognitive, and Social Dimensions of Life into a Science of Sustainability*. New York: Doubleday, 2002.
- Carson, Rachel. *Silent Spring*. Anniversary Edition. New York: Mariner Books, 2002 (originally published in 1962).
- Clayton, Philip. *Mind and Emergence: From Quantum to Consciousness*. New York: Oxford University Press, 2006.
- Davies, Paul, and Niels Gregersen, eds. *Information and the Nature of Reality*. Cambridge: Cambridge University Press, 2010.
- Dick, Steven, and Mark Lupisella, eds. *Cosmos & Culture: Cultural Evolution in a Cosmic Context*. Washington, DC: NASA SP-4802, <http://history.nasa.gov/SP-4802.pdf>, 2010.
- Ehrlich, Gretel. *Solace of Open Spaces*. New York: Penguin, 1985.
- Eiseley, Loren. *The Immense Journey*. New York: Vintage, 1956.
- Holland, John. *Emergence*. Reading, MA: Addison-Wesley, 1998.

- Holmes, Barbara A. *Race and the Cosmos: An Invitation to View the World Differently*. Harrisburg, PA: Trinity Press International, 2002.
- Impey, Chris. *The Living Cosmos: Our Search for Life in the Universe*. New York: Random House, 2007.
- Jantsch, Erich. *The Self-Organizing Universe: Scientific and Human Implications of the Emerging Paradigm of Evolution*. New York: Pergamon Press, 1980.
- Jencks, Charles. *The Garden of Cosmic Speculation*. London: Frances Lincoln, 2003.
- Johnson, Steven. *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*. New York: Scribner, 2002.
- Kauffman, Stuart. *At Home in the Universe*. New York: Oxford University Press, 1995.
- Kelso, J. A. Scott, and David Engstrom. *The Complementary Nature*. Cambridge: MIT Press, 2006.
- Leopold, Aldo. *Sand County Almanac*. New York: Oxford University Press, 1966 (first published in 1949).
- Lockwood, Michael. *The Labyrinth of Time: Introducing the Universe*. Cambridge: Cambridge University Press, 2007.
- Lopez, Barry. *River Notes: The Dance of the Herons*. New York: Avon Books, 1979.
- Mainzer, Klaus. *Thinking in Complexity: The Computational Dynamics of Matter, Mind, and Mankind*. Berlin: Springer, 2007.
- Miller, James Grier. *Living Systems*. New York: McGraw-Hill, 1978.
- Mitchell, Melanie. *Complexity: A Guided Tour*. Oxford: Oxford University Press, 2009.
- Morowitz, Harold. *The Emergence of Everything: How the Universe Became Complex*. New York: Oxford University Press, 2004.
- Nadeau, Robert, and Menas Kafatos. *The Non-local Universe: The New Physics and Matters of the Mind*. New York: Oxford University Press, 2001.
- Nunez, Paul. *Brain, Mind, and the Structure of Reality*. Oxford: Oxford University Press, 2010.
- Oliver, Mary. *New and Selected Poems*. Boston: Beacon Press, 1992.
- Prigogine, Ilya. *From Being to Becoming: Time and Complexity in the Physical Sciences*. San Francisco: Freeman, 1980.
- Prigogine, Ilya, and Isabelle Stengers. *Order out of Chaos: Man's New Dialogue with Nature*. New York: Bantam Books, 1984.
- Rogers, Patiann. *Fire-keepers: New and Selected Poems*. Minneapolis, MN: Milkweed, 1994.
- Scott, Alwyn. *The Nonlinear Universe*. Berlin: Springer, 2007.
- Skrbina, David, ed. *Mind that Abides: Panpsychism in the New Millennium*. Amsterdam: John Benjamins, 2009.
- Snyder, Gary. *Back on the Fire*. Berkeley: Shoemaker & Hoard, 2007.
- Swimme, Brian, and Thomas Berry. *The Universe Story*. San Francisco: HarperSanFrancisco, 1992.
- Teilhard de Chardin, Pierre. *The Human Phenomenon*. Portland, OR: Sussex Academic Press, 2003.

- Thompson, Evan. *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge: Harvard University Press, 2007.
- Toolan, David. *At Home in the Cosmos*. Maryknoll, NY: Orbis Books, 2001.
- Toulmin, Stephen Edelston. *The Return to Cosmology: Postmodern Science and the Theology of Nature*. Berkeley: University of California Press, 1982.
- Toulmin, Stephen, and June Goodfield. *The Discovery of Time*. Chicago: University of Chicago Press, 1977.
- Wheeler, Wendy. *The Whole Creature: Complexity, Biosemiotics and the Evolution of Culture*. London: Lawrence and Wishart, 2006.
- Whitehead, Alfred North. *Process and Reality: An Essay in Cosmology*. New York: Free Press, 1929.
- Whitfield, John. *In the Beat of a Heart: Life, Energy, and the Unity of Nature*. Washington, DC: Joseph Henry Press, 2006.
- Williams, Terry Tempest. *Refuge*. New York: Vintage Books, 1991.