Fahrenheit 451,000
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A physicist demonstrates that the evolution of the universe is a history of its temperature.

A MATTER OF DEGREES
What Temperature Reveals About the Past and Future of Our Species, Planet, and Universe.
By Gino Segrè.
Illustrated. 300 pp. New York: Viking. $24.95.

By Marcia Bartusiak

GINO SEGRÈ opens his book with a cunning observation: "Our ability to measure temperature is only a few hundred years old." Early scientific investigators were far more proficient at measuring time and space than understanding heat and energy. Yet, as Segrè, a theoretical physicist at the University of Pennsylvania, emphasizes in "A Matter of Degrees," much of nature is ruled by temperature. So he examines a host of scientific matters from a thermodynamic perspective.

Thus he links oceanography to particle physics: "The radioactive alpha particle decay of a few kinds of nuclei heats the Earth's crust, which convectively creates fire just below the surface. Forced up through the ocean bottom in hydrothermal vents, this activity somehow sustains life that evolves to create creatures that think about radioactivity." His approach — to find a "unity of experience" through temperature — is both refreshing and rewarding. We learn not only how bees cool off but also how Einstein designed and patented a refrigerator in 1926.

Segrè has an easygoing style, sprinkled with anecdotes and history, that immediately draws you in; it is like listening to a graceful conversation. He starts with the evolution of mechanisms to maintain our bodies' steady temperature of 98.6 degrees, which leads into an engaging digression on the physics of fans. He then briefly tackles no less than the history of civilization: "If I were to employ temperature as my record for a narrative of civilization, I would cite the ever-hotter fires humans made as they moved from hunter-gatherers to villagers to toolmakers." From wood and charcoal to steam and oil. Today we can not only mimic the interior of a star but plunge downward in temperature as well, to within billionths of a degree above absolute zero.

Just 200 years ago, most scientists thought of heat as a substance called phlogiston (Greek for "combustible"), a fluid invisibly oozing into and out of objects. Modern thermodynamics was established when it was at last recognized that heat is energy, linked to the vibration of atoms. Understanding such principles ultimately led to one of the greatest discoveries in physics, quantum mechanics.

Since the theme is temperature, the largest portion of this book is devoted to ice ages, global warming and the warm ocean current El Niño. Along with a historical overview (the French mathematician Jean-Baptiste Fourier described the atmosphere's trapping of heat as a greenhouse effect in 1822), Segrè provides a compact synthesis of some of the latest findings on these topics. He vividly describes the Pompeii worms that thrive on hydrothermal vents deep in the ocean. Their tails lie near the scorching water jet, somehow surviving 170 degrees Fahrenheit. This allows the cooler waters at their heads to be thermally siphoned through their four-inch bodies for nutrition. Segrè points out that the sudden appearance of multicellular life half a billion years ago, an event known as the Cambrian explosion, may be linked to the end of "snowball earth," a controversial theory that a miles-thick layer of ice covered Earth for 200 million years.

Segrè explains how temperature oversees the development of both our solar system and the universe. Within the primordial cloud enveloping the young Sun, rocky grains and dust near our star coalesced into Mercury, Venus, Earth and Mars. Farther out, extremely low temperatures could freeze vapors into ice balls so massive that remnant disk gases were attracted to form the giant outer planets. The evolution of the universe is a history of its temperature, from the Big Bang's cosmic fireball of 100 billion degrees to today's chilly space-time temperature of three degrees above absolute zero.

To science aficionados this territory is familiar. But for newcomers Segrè's book is a pleasurable introduction to many key scientific ideas. □