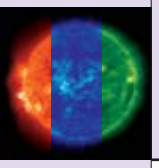


the Sun and the Earth

DR

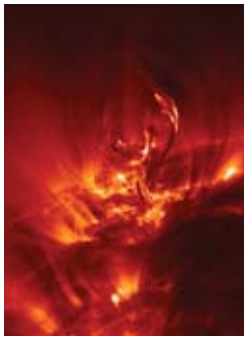
Pierre Léna

The Sun: since humans have been around on this Earth, was there a single object in the world so captivating to the eye, enthralling to attention, inquiry, imagination? To have a star at hand is not a prospect available to all planets - a star that will shine long enough, that is not too close to escape being scorched by it, nor too distant to draw energy from it, just in the right position to allow water to run through its cycle, from ice through liquid to vapor, and thus nurture life, forests, and crops. By contrast to so many of the fascinating objects in astronomy, this star was never discovered: it is, and remains, there. It was made into a god, adored by entire civilizations, taken for an emblem by kings or empires, one fleeing the labyrinth melted his wings before it, others feared but that it might come down onto their heads. Celebrated by poets, it stands as the paradigm for light, the fount of colors and shadows for the painter, the sculptor or the architect, a disconsolate absence for the blind.

Its daily course, its seasonal excursions begat the rhythms of the calendar, and the temporality of history, from its shadows there arose clocks, from its position the seasons and climes, latitudes and geography. Its eclipses inspired alarm, reviving the ancient dread of an extinct Sun.

One day, in the time of the miracle that was Greece, it became an object of knowledge, and science: Anaxagoras of Clazomenae was banished from Athens for contemplation of it to excess, then, by astounding good luck, Aristarchus of Samos - who deemed it to be a fiery rock larger than the Peloponnese - estimated its distance with a good measure of accuracy. After geometry came mechanics: who, of Aristarchus - already -, then Aristotle and Ptolemy, or Copernicus, finally, might account rationally for the relative motions of Sun and Earth? Galilean relativity, born on Lake Piediluco, and

“This astounding physics laboratory, this generous, inexhaustible source of energy that is simply known as our star, the Sun.”



Lockheed-Martin Solar and Astrophysics Laboratory

ÉjCoronal matter ejection on the surface of the Sun, as observed by the Trace satellite.

Newtonian dynamics brought the dispute to a close: the Sun entered the realm of physics, never to leave it again. Its mass was determined, it gave its name to helium, the first extraterrestrial element, discovered by James Lockyer in 1869. During a solar eclipse in 1919, measurement of the displacement of the images of stars, close to the Sun's rim, invalidated Newton's prediction, and brilliantly corroborated Albert Einstein's relativity. In 1939, at the threshold of a war that would sow death by way of "a thousand suns," harking back to the million suns of the Mahabharata, physicist Hans Bethe showed that it is indeed the nuclear fusion of hydrogen that is the source of the Sun's brightness, as of all stars. We now know that the Sun, having nurtured so many civilizations, is no less mortal than the latter, though it confer on them yet a near-unfathomable durability. That same year, 1939, having invented the coronagraph, French astronomer Bernard Lyot made Flammes du Soleil (Flames of the Sun), that first, magnificent film of the chromosphere and corona regions: the way now lay open, to the investigation of the matter the Sun is constantly spewing out into space.

Half a century of physics, forty years of observations made out in space by means of solar telescopes have resulted in outstanding knowledge of our star. What to single out, in that huge body of lore, of which the reader will discover a number of elements in the pages that follow? Should one go for the exploration of the solar interior, which seemed to be forever inaccessible, but which is now mapped out through the seismic tremors and minute vibrations of this heavenly body, the oscillations in its brightness? Or for the detection of the neutrinos, those particles issuing from the very core of the Sun, reaching us without let or hinder, whereas photons, going from collision to collision, take thousands of years to get out? Or the seething of its surface, its magnetic fields and eruptions, that grandiose sunscape the telescopes positioned out in space, working in the X-radiation or ultraviolet domains, are ceaselessly mapping out? This is where the relationships between Sun and Earth play themselves out, in what is now known as space meteorology, which, in the long term, may well determine the entire history of the Earth's climates.


Phovoir

To judge by the advances recounted in the articles that follow, one might imagine a rounded view has been arrived at of the Sun: such is the enduring illusion of knowledge, to believe itself to be complete! Indeed, every one of these breakthroughs opens up new prospects, new questions.

Arguing in support of Copernicus, Cyrano de Bergerac wrote, in 1649: "… It is common sense to believe the sun has taken up its position at the center of the universe, since all the bodies that are in nature need that radical fire, which dwells at the heart of the realm to be able promptly to satisfy the requirement of each part…"

From agriculture to fossil fuels, photosynthesis promptly satisfied our unabating and ever-increasing requirement for energy.
The ability to domesticate fusion energy appears nowadays as less distant a prospect than two decades ago. Physics and chemistry have not yielded their last, as regards production of materials having the capacity to generate efficiently electrical resources from sunlight. To take up the neologism put forward by Jack Williamson in 1942, nothing is to stop us from conjuring up the vision of terraforming a sun-drenched Mars, which we now know for certain to be harboring water.

To the poets' "sodden suns of these overcast skies," "the black sun of melancholy," "the blazing sun abettor of my joy" - as sung by Baudelaire, Nerval and Verlaine -, the counterpart is this astounding physics laboratory, this generous, inexhaustible source of energy that is simply known as our star, the Sun.

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StockTrek/NASA

Solar reflections on the Earth's atmosphere, seen from a Space Shuttle.