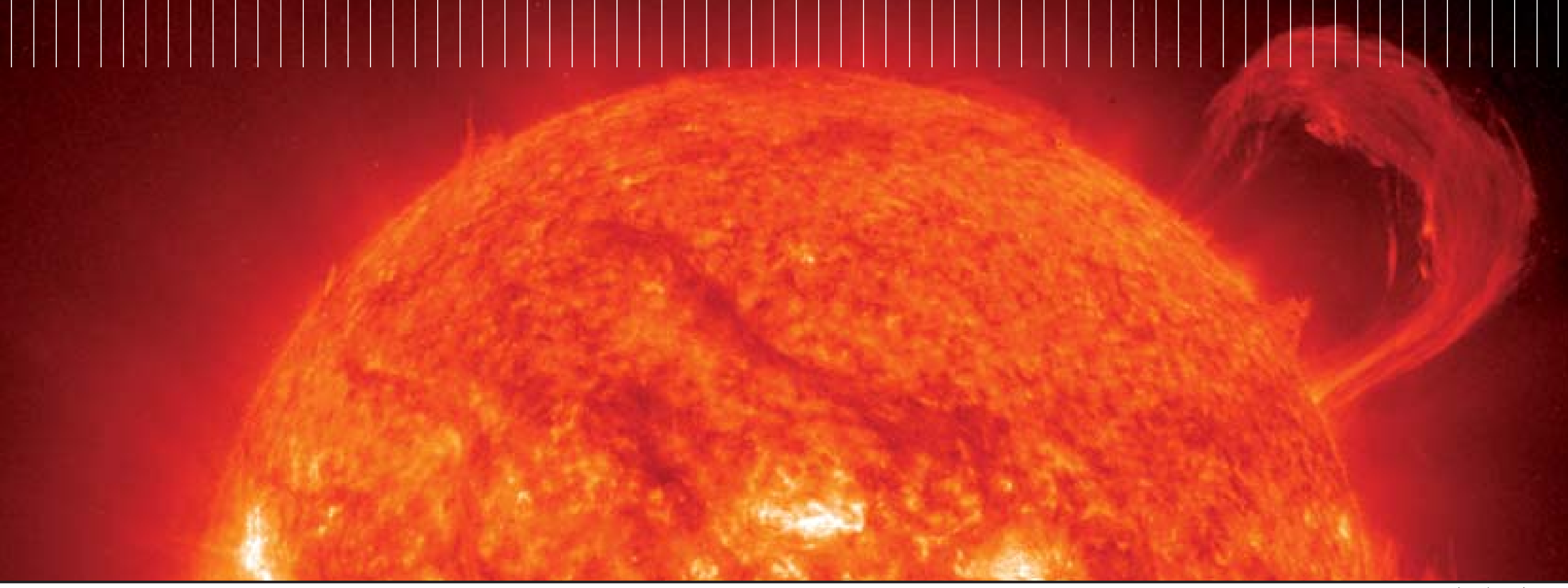

SOHO (ESA/NASA)

The Sun, observed at a wavelength of 304 angstroms by the Extreme-Ultraviolet Imaging Telescope instrument, on board the SOHO satellite. Emission in this part of the spectrum shows the upper part of the chromosphere, with a temperature of the order of 60,000 kelvins, and prominences some of which may attain, as seen here, altitudes in the hundreds of thousands of kilometers.

I. UNDERSTANDING THE SUN STAR

Though we now know that the Sun is not the center of the Universe, but an altogether run-of-the-mill star, we do want to understand how it was born, and how it works. Was it not the Sun that made it possible for the Earth to be formed, and life to emerge? Are we not children of the Sun?

Now, our understanding of the Sun has made huge strides over the past few years. The main reason for this? The emergence of an extremely powerful approach, helioseismology. This technique, described in the following pages by Sébastien Couvidat and Rafael Garcia, consists in probing the Sun's interior by means of the acoustic waves observed on its surface, thus obtaining profiles for the speed of sound, density and even rotation, as a function of depth.

For the past eight years, three instruments mounted on the SOHO satellite, including one built in collaboration with CEA, have been monitoring the Sun constantly, supported by ground-based networks, themselves the outcome of international collaborative efforts. With such a diagnostic, we have gone from speculation – guided by physical intuition though this undoubtedly was – to the building up of much more reliable models, as shown by Sylvaine Turck-Chièze.

These seismic models have achieved a precision such that they only left one explanation open, to account for the deficit in solar neutrinos found on Earth, namely that the neutrino bore an unsuspected property, that had not been allowed for by standard theory. Michel Cribier recounts how this property was uncovered, bringing to an end a debate that had long opposed astrophysicists and particle physicists: contrary to what had been believed thus far, the neutrino does have a mass, and it oscillates between two states, only one of which is detected by our instruments. Taking this effect on board, the neutrino flux, as measured, is in excellent agreement with the latest seismic models.

Modeling of the Sun has recently taken another major step, thanks to the ever-growing computing capability of supercomputers: as it becomes three-dimensional, and achieves sufficiently high resolution, this now enables description of the turbulent motions occurring in the convective region. The numerical simulations presented by Sacha Brun finally allow an understanding to be gained, as to why it is the Sun rotates more rapidly at the equator than at the poles. And they warrant the hope that the dynamo mechanism giving rise to the Sun's magnetic field, responsible as this is for the many facets of its activity, may soon be accounted for.

Nor is it to be wondered at, that CEA teams are strongly involved in solar research, and are actively contributing to bringing renewed impetus to the field. Indeed, how could CEA, one of whose priorities is mastery of fusion processes, fail to show interest in this "gravitational-confinement thermonuclear reactor,"to quote Michel Cassé's pregnant phrase?

> **Jean-Paul Zahn**
Paris Observatory