LETTERS

Solar Luminosity Eludes Understanding

I enjoyed Eugene N. Parker's fine article on the Sun (PHYSICS TODAY, June, page 26). However, his statement that the correlation between solar luminosity and magnetic activity levels is "not at all understood" requires correction, given the broad relevance of this topic to global climate policy.

The modest resemblance between total irradiance variation and sunspot number shown in Parker's figure 6 no longer does justice to the fact that almost 90% of the measured variance in total irradiance is now accounted for by a simple empirical model based on the projected areas and photometric contrasts of dark spots and bright magnetic regions called faculae.[1] Stirring of solar convection by rising magnetic flux, which Parker mentions as a hypothesis, may play a minor role, but it fails to explain why the observed luminosity variation is closely proportional to the difference between the compensating effects of sunspot and facular flux tubes, rather than to their total magnetic flux.

The simplest physical explanation of the observed solar luminosity variations is provided by analytical and numerical studies of time-dependent heat flow around the spots and faculae. These simulations show that the heat flow blocked by spots (or made more efficient by faculae) is not quickly compensated by the heating (or cooling) of their surroundings. Instead, a small change occurs in the thermal and potential energy of the solar envelope, for much longer than the lifetime of these magnetic structures.[2,3]

The subject of solar luminosity variation has advanced from almost total ignorance 20 years ago, to observational and theoretical understanding that ranks as an important recent advance in our grasp of the Sun's workings. Readers interested in the mechanisms of solar and stellar luminosity variations can find a comprehensive description in the review by Henk Spruit.[4]

References

1. C. Frohlich, J. Lean, Geophys. Res. Lett. **25**, 4377 (1998).
2. H. Spruit, Astron. Astrophys. **108**, 348 (1982).
3. P. Foukal, L. Fowler, M. Livshits, Astrophys. J. **267**, 863 (1983).
4. H. Spruit, in *Proc. IAU Colloquium 143*, J. Pap *et al.*, eds., Cambridge U. Press (1994), p. 270.

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PARKER REPLIES: Peter Foukal is correct that the varying solar luminosity arises directly through the coming and going of the bright faculae minus the dark sunspots. He was one of the key players in establishing that important fact. However, the extra energy passing out through the faculae has to come from somewhere. In section 5 of an earlier paper,[1] it is estimated that the energy flux at the surface responds to the temperature and energy supply at a depth of 10^4 km with a lag of less than 10^7 seconds. A brightening over several years (10^8 s) requires an enhanced convective energy supply upward across the depth of 10^4 km. Without this energy supply, the surface brightening would soon fade.

In that earlier work I also estimated that the magnetic flux bundles, rising to the surface and creating the sunspots and faculae, stir the ambient gas and adequately enhance the upward convective heat transport. That suggestion is unsubstantiated, however; we really do not properly understand the physics of the varying luminosity of the Sun.

Reference

1. E. N. Parker, Astrophys. J. **440**, 415 (1995).

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PHYSICS TODAY's Electoral Preference

Your special report on the presidential candidates (PHYSICS TODAY, October, page 61) featured a grainy news photo of a frowning Bush and a well-lit portrait photo of a smiling Gore. While you succeeded in making it clear which candidate you favored, there are more honorable ways of expressing a preference.

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[PHYSICS TODAY's only preference is that we have an educated electorate. Nevertheless, the above letter is representative of several similar reactions that we received. In early September, we asked both campaigns for "presidential portraits" of their candidate, and they directed us to their preferred Web sites. The Gore campaign had a good selection of photos for the media. The Bush campaign had only news photos of the candidate in large groups of people. We used the only one that could be sufficiently enlarged for a portrait.
—The Editor-in-Chief]

Japanese Team Measures Tropical Instability Effects

The article on ocean–atmosphere research by Charles Day (PHYSICS TODAY, June, page 23) is an excellent introduction to tropical instability waves and their interaction with the atmosphere. While stressing the need for in-situ measurements, the article failed to mention that, in October 1999, a team of Japanese scientists aboard the research vessel *Shoyo Maru*[1] had already completed such a survey. The radiosonde measurements revealed the vertical structure of atmospheric variations associated with tropical instability waves.[2] A major finding from this research voyage was that the atmospheric response penetrates at least as deep as the planetary boundary layer (~1 km), key information for determining which mechanism is most important.

References

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2. W. T. Liu, X. Xie, P. S. Polito, S.-P. Xie, H. Hashizume, Geophys. Res. Lett. **27**, 2545 (2000).

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