CC/NUMBER 26
JUNE 29, 1981

This Week's Citation Classic

Gingerich 0, Noyes R W, Kalkofen W & Cuny Y. The Harvard-Smithsonian reference atmosphere. *Sol. Phys.* **18:**347-65, 1971.
[Smithsonian Astrophysical Observ. and Harvard Coll. Observ., Cambridge, MA and Observatoire de Paris, Section d'Astrophysique, Meudon, France]

The HSRA tabulates the physical conditions for the thin outer layers of the sun's radiant atmosphere. It gives the temperature and pressure as a function of depth and it shows the emergent spectral intensity from the infrared to the far ultraviolet. [The *SCI®* indicates that this paper has been cited over 430 times since 1971.]

Owen Gingerich
Harvard-Smithsonian Center
for Astrophysics
60 Garden Street
Cambridge, MA 02138

April 17, 1981

"The most astonishing thing about the HSRA is its longevity. As a physical description of the outer layers of the sun it was the third in a succession of models,[1,2] and its predecessors each stood as authoritative for only three years; yet the HSRA continues to be cited about every other week, a decade after its publication.

"The reasons for this unexpected longevity are partly that the paper included particularly complete tables, and also that the field of 'stellar atmospheres' had reached a natural cadence after an explosive development during the 1960s. This rapid progress had been made possible by the burgeoning access to high-speed computers. I was fortunate to get in on the ground floor just at the time the Smithsonian Astrophysical Observatory had been catapulted into the forefront of astronomical computing on account of the Observatory's satellite tracking activities. In retrospect those seem like heroic days. Computing power that today fits in a small suitcase then required a large roomful of vacuum tubes, and I remember vividly how the engineers used to debug the IBM 704 by systematically tapping the tubes one after another with a mallet!

"With the proliferation of scientific rockets and satellites during the same decade, it became possible to probe the solar spectrum in the ultraviolet; simultaneously, observations were extended into the infrared. The sun is most transparent in the infrared at 1.65 μ, so there we can effectively probe about 25 kilometers deeper than with green or yellow light. In contrast, at longer wavelengths and in the ultraviolet the solar atmosphere is more opaque, and so we can use these spectral regions to explore the outermost layers of the solar photosphere and the so-called chromosphere. Astronomers had long known that the solar corona was much hotter than the photosphere, but for the first time we could actually trace out the solar minimum temperature region. In 1968, we first employed rocket observations to build a solar model on an extended spectral data base, but barely had that model appeared when my colleagues and I began to make it obsolete.

"By the end of 1970 we had enough new data from satellites, rockets, and high-flying aircraft, as well as increased sophistication with respect to the physical processes involved in the interpretation, to submit a new standard. We boldly labeled it the 'Harvard-Smithsonian Reference Atmosphere,' in recognition of the observatories where we worked. In the paper we expressed our expectation that the new model would also be short-lived, and we even added a note in press pointing to some of its defects, but apparently we hit it close enough so that further refinements, which came almost immediately, do not alter the model enough to keep it from being used rather frequently for comparison purposes. Thus, although the model did not break much new ground physically, it did represent a culmination of a decade of computer program development and astrophysical interpretation, and it still serves to define approximately the run of temperature, pressure, and ionization conditions within the solar atmosphere. The work that will probably replace the chromospheric part of the HSRA has just been published."[3]

1. **Gingerich O & De Jager C.** The Bilderberg model of the photosphere and low chromosphere. *Sol. Phys.* **3:**5-25, 1968.
2. **Heintze J R W, Hubenet H & De Jager C.** A reference model of the solar photosphere and low chromosphere. *Bull. Astron. Inst. Netherlands* 17:442-5, 1964.
3. **Vernazza J E, Avrett E H & Loeser R.** Structure of the solar chromosphere. III. Models of the EUV brightness components of the quiet sun. *Astrophys. J. Suppl. Ser.* **45:**619, 1981.