Is the Sun Shrinking? Two Views

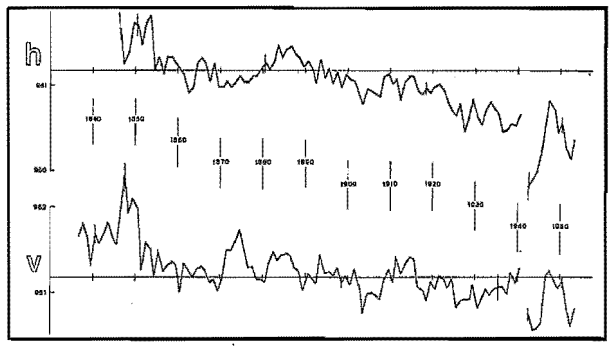
Astronomers of old were sticklers for detail. For more than two centuries they meticulously measured the diameter of the sun by observing how much time it took the solar disk to cross a fixed line of sight. The measurements originally were made to determine the exact position of the sun with respect to the stars, but modern-day scientists now find that the old data may give us a new understanding of how the sun works.

After analyzing solar diameter data recorded both at the Royal Observatory at Greenwich between 1836 and 1953 and at the U.S. Naval Observatory since 1846, John A. Eddy and Aram A. Boornazian conclude that the solar diameter has been shrinking for the past hundred years, perhaps for as long as 400 years. Eddy, a visiting scientist at the Harvard-Smithsonian Center for Astrophysics, and Boornazian, a mathematician with S. Ross and Co. in Boston, calculate the shrinkage to be about 2 arc seconds per century in the sun's horizontal dimension (approximately 5 feet per hour) and about half that vertically. The shrinkage does not apply to the entire solar mass, but rather to the sun's outer layers.

Since the rate of shrinkage is so fast, the two researchers believe it is only a temporary contraction phase. "It's unrealistic to assume this will continue," Eddy told SCIENCE NEWS. "It does seem to imply that the sun is oscillating in some way. However, going farther back into time to find an expansion will be difficult since the records get dimmer and dimmer."

The researchers were able to go as far back as the 16th century. The path of a solar eclipse passed over Rome in 1567. If the sun were the same diameter as it is today, the eclipse should have been total. But Clavius, an observer of the celestial event at the College of Rome, wrote that the moon "did not obscure the whole Sun ... but a certain narrow circle was left on the Sun, surrounding the whole of the Moon on all sides." Eddy and Boornazian say this leaves little doubt that Clavius observed an annular eclipse, the type that would have been seen if the sun were slightly larger four centuries ago.

Though still a matter of speculation, a shrinking sun could provide the solution to the great solar neutrino mystery (the fact that the sun gives off fewer neutrinos than predicted by current solar models). In a paper presented to the American Astronomical Society in mid-June, Eddy and Boornazian reported, "If only the outer 20 percent of the Sun's radius is involved — the convective zone — enough energy would be supplied to make up the deficit that falls when we take the presently measured neutrino flux as indicative of the real temperature of the solar core. The implication is that the Sun and presumably other similar stars could now be deriving a significant part of their energy from gravitational contraction."



Annual averages of the sun's horizontal (h) radius and vertical (v) radius in arc seconds from 1836 to 1953. A straight line fit to the data gives an apparent shrinkage of about 2 arc seconds per century in the horizontal.

Eddy and Boornazian

Bringing gravitational contraction into the picture dusts off an old 19th century concept used to explain the sun's energy output before nuclear fusion was known. "The deficit of neutrinos already shows that the nuclear model needs a change," says Eddy. "I won't be surprised to see a future model where the sun is getting its energy from several mechanisms." The solar astronomer speculates that the gravitational contraction may act like a governor. When energy from the solar core decreases, the contraction could make up the loss, thus modulating the sun's total luminosity.

But the final verdict is not in on the Greenwich observatory data. A group of scientists at the Goddard Space Flight Center have an interpretation that differs from that of Eddy and Boornazian.

After studying the solar diameter measurements made between 1850 and 1937, Sabatino Sofia, John O'Keefe and Janet R. Lesh, along with Louisiana State University physicist Andrew S. Endal, report in the June 22 SCIENCE that "there is evidence for a slow systematic decrease of the observed radius by about 0.2 arc second over this time." This is much smaller than Eddy's finding.

O'Keefe says the difference lies in the measurements each chose to use. While Eddy believes the horizontal measurements of the sun's diameter were more accurate, since they were done with a clock, the NASA researchers took the opposite view. "We confined ourselves to the vertical measurements," says O'Keefe, "since they were done with a micrometer. This was more precise at the time."

But a decreasing solar radius was not the main concern of the NASA group. Rather, it was whether the Greenwich data point to any large changes in the solar constant (a measure of the sun's energy output) over the last century. O'Keefe's answer: They don't.

To reach that conclusion, it was assumed that a fractional change in the sun's radius is directly proportional to a fractional change in the solar constant. A standard deviation of .25 arc second in the mean solar radius was considered the upper limit to the radius's variation during that 87-year period between 1850 and 1937. The trend toward a decreasing radius was included in this deviation. From their complex model of the sun's convective efficiency for periods of about 100 years, such a variation in the radius led to the conclusion that the solar constant could not have changed by more than .33 percent during that time.

"Our study definitely shows that...1 to 2 percent change[s] in the solar constant over the last century did not take place," says Sofia. He would now like the SCLERA telescope in Arizona to make measurements of the solar diameter in order to provide a highly accurate monitor of future changes in the solar constant. □

Carter's solar program

President Jimmy Carter's new solar energy package, announced to Congress June 20, sets a goal of meeting 20 percent of all U.S. energy needs by the year 2000 using solar and renewable sources. The program's centerpiece is a $405 million Solar Development Bank. Some further incentives would include tax credits for domestic, industrial and agricultural designs using solar technology, tax credits for airtight wood-burning stoves, and a permanent federal excise tax exemption for alcohol fuels. Carter also plans to expand his proposed budget for solar energy programs to $1.1 billion to encourage international use of solar technology through the Agency for International Development.

Pivotal to Carter's proposal is the passage of his "windfall profits" tax that would