signals resulting in proliferation and differentiation of the B and T cells, and histamine release from the mast cells. A similar signal might be generated by the viral protein gp30 explaining the polyclonal B-cell proliferation (persistent lymphocytosis) connected with BLV infection.

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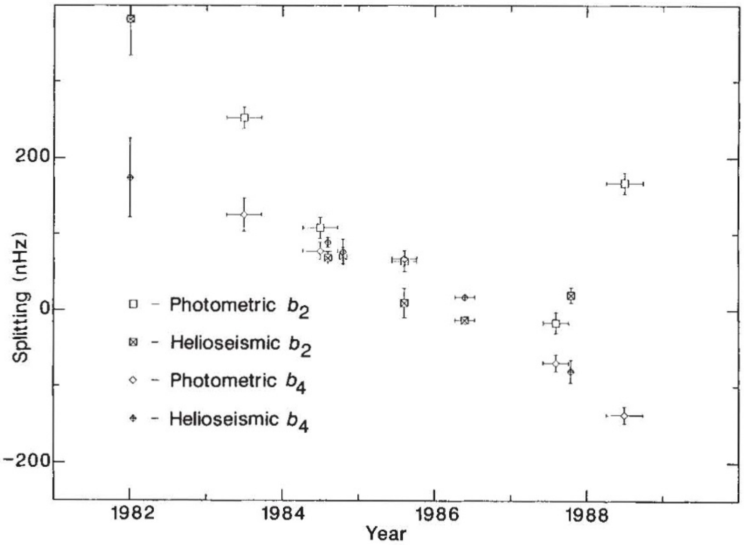
Solar oscillation

SIR—Gough discusses the recent helioseismic evidence for solar-cycle variations in the global solar aspherical structure. But he does not mention that the variable, even, helioseismic-splitting coefficients; the solar-limb temperature measurements; and the solar-constant data together yield a consistent interpretation of solar asphericity. Gough speculates that the splitting coefficients are directly related to sunspot number, and using a Legendre polynomial decomposition of the surface distribution of sunspots, makes a prediction[2]. It is not obvious, however, that the sunspot number (surface density) and frequency splittings should be plotted on the same graph. This approach contrasts with my earlier calculation[3,4] which explicitly predicts the splittings from an asphericity in the sound' speed. These model predictions have been confirmed by observation.[5].

In his report[1], Gough criticizes the limb temperature observations and inferences because they do not account for the variability of the mean solar irradiance measured by ACRIM. In fact the limb data nicely explain[6] the observed cycle variation of the solar constant. Furthermore, the formalism and data directly provide information on the depth dependence of the asphericity. For example, I have used the helioseismic observations to show that the asphericity is best described by a perturbation in the outer superadiabatic layer of the convection zone[3]. Thus, unlike Gough, I find it hard to see how the helioseismic data can be interpreted to explain a measureable solar-cycle variation in the neutrino flux from the Sun's core.

In any case, Gough's 'prediction' may soon be tested. Splitting data from 1988 should show large changes (and significant centroid frequency shifts) from 1987. In contrast with Gough[2] I expect the b_4 (α_4 in ref. 2) splitting coefficient to be even smaller than in 1987 (see figure). Note that this is not a correlative inference, but a test of a simple model consistent with observed solar irradiance variations.



Time dependence of the helioseismic splitting measurements[3,4]. The most recent photometric observations are from limb photometry obtained in 1988. In contrast with Gough[2], I expect the b_4 coefficient to decrease in 1988.

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GOUGH REPLIES — That the even splitting coefficients of solar 5-minute oscillations should arise predominantly from a latitudinal variation in the propagation speed c of acoustic waves rather than a geometrical distortion of level surfaces is a natural supposition. The frequency splitting $\delta\nu/\nu$ between sectoral and zonal modes was $\sim 2\times10^{-4}$ in 1982 near the solar maximum[7], whereas the oblateness at that time was probably no greater than 2×10^{-5} (ref.8). Moreover the frequency splitting induced by the oblateness is of opposite sign to that observed.

What is the nature of the variation in c? The most natural thought is that it is a sound-speed variation, associated with a variation in temperature. Simple models of the solar envelope in which thermal asphericity is induced by magnetic inhibition of convection in the equatorial regions, yet which maintain radial hydrostatic balance, reproduce the splitting data[9]. But they require a photospheric temperature variation that is a hundred times greater than recent observations indicate[6]. What is remarkable, however, is Kuhn's finding[3,4] that if the observed latitudinal variation in relative temperature[6] away from the poles is assumed to extend essentially unmodified through the superadiabatic convective boundary layer, then the splitting data are reproduced.

It was the original failure of plausible hydrostatic-envelope models to explain the splitting data that induced an investigation of magnetic effects, particularly as the asphericity was similar to the sunspot distribution. A non-uniformly distributed fibril magnetic field of magnitude similar to that observed reproduces the required frequency splitting[9]. It was that result that led me previously[2] to assume a correspondence between magnetic activity, measured by sunspot density, and $\delta c/c$.

From an extrapolation of the sunspot data from 1 January 1988 I thus predicted the results of measurements being carried out in Antarctica by a team from the US National Solar Observatory. Recently, R. K. Ulrich kindly provided me with Mt Wilson sunspot data up to 25 November 1988. Using the scaling from my letter[2] these data provide a revision of the prediction to $\alpha_2\approx170$ nHz, $\alpha_4\approx-110$ nHz; thus in contrast with my previous extrapolated result α_4 seems still to be declining, in agreement with Kuhn's expectations.

The new discussion of limb brightness measurements[6] was not available when I wrote my first report[1]. The impressive correspondence with the ACRIM data lends considerable credence to the interpretation in terms of effective-temperature variations, and thus demands a consistent theoretical investigation of its implications concerning the dynamical balance of the convection zone and the splitting of oscillation frequencies.

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