Theory of Solar Variation.

D. O. Gough

Institute of Astronomy and Department of Applied Mathematics
and Theoretical Physics, University of Cambridge - Cambridge, U.K.
Joint Institute for Laboratory Astrophysics, University of Colorado
and National Bureau of Standards - Boulder, CO
1. - Introduction.

On inviting me to deliver these lectures, Prof. Giuliana CASTAGNOLI-CINI asked me to address, amongst other things, the theoretical predictions of solar variation on time scales that might be accessible from terrestrial fossil data: in particular, the time scales 22 years and $10^4$ years. At the outset I must point out that our knowledge of the evolution of the Sun is so rudimentary that the only relevant variation about which astrophysicists are really sure (presuming that the laws of physics as we know them today have always been so) is the gradual rise in the luminosity over the main-sequence lifetime similar to that given by eq. (4.7). Theoretical ideas about all other variations are either little more than pure conjecture or, in the case of the 22 $\gamma$ solar cycle, rationalizations of the observations. What Prof. CINI had originally in mind was that astrophysicists could be of substantial assistance in helping to unravel the variations in the fossil record, but it appears to me that, subject to caveats such as that which I discuss in connection with the solar cycle, the terrestrial data might at first be offering the evidence for solar variation, and so helping astrophysicists understand the internal dynamics of the Sun. The time scale of $10^4$ years of which solar physicists are well aware as being characteristic of an unexplained variation in the climatic record is one such example; at present there is no theoretical prediction of a solar variation on that time scale, and all that can be offered is merely a statement of the thermal-relaxation time of the solar convection zone and the characteristic time for destroying $^4\text{He}$ in the Sun's energy-generating core. They are included in tables II and III, respectively.

It could be argued that these lectures should, therefore, be viewed as little more than an apology. I consider them to be more than that. By revising our current ideas of the structure and possible evolution of the Sun I might