CORRESPONDENCE

To the Editors of 'The Observatory'

Fred Hoyle's unpublished theory of a 12 × 10^9-yr-old Solar System

In the autumn of 1997 Fred Hoyle suffered an accident while walking in Shipley Glen near his family home in Gilstead, West Yorkshire. It took the best part of three months for a broken shoulder to heal and another month before he was able to write again. It was towards the end of his convalescence that he revisited a problem that he had first began to ponder in the 1930s in collaboration with Ray Lyttleton[1,2]. An unpublished document written in 1997 that develops a remarkable and provocative theory is currently lodged in the archives at St John's College, Cambridge. The document is titled *A Different Approach to the Age of the Earth*. He had shown this to several friends and colleagues who urged him to publish, but it remains unpublished to the present day.

Once or twice a month Fred would go out for the day with one of us (GH), often lunching in a Devon or Cornish pub. The conversation on those occasions would swing through many subjects, and inevitably on one particular day the age of the Sun and planets reached the top of the agenda. There were two avenues he said he was following. One was to explain the very large angular momentum of the Sun in its orbit around the centre of the Galaxy, and the second was to explain the distribution of angular momentum between the Sun and the planets. The Sun carries 99% of the mass of the Solar System but only contained one per cent of the total angular momentum, a situation that demanded an explanation.

The answer to the second question had progressed well through Fred's career and an account of it was set out, for instance, in his collaboration with one of us (CW) in a paper published in 1968[3]. But the answer to the first of the problems had continued to elude him. The difficulty was to explain why the *total angular momentum per unit of mass* in the Solar System had exactly the value it had. The nub of the problem, it seemed to Fred, lay in describing the Sun as a star in a wrong sort of galaxy, in an elliptical galaxy instead of a spiral galaxy — bizarre as it would appear at first sight, but by no means absolutely impossible.

By examining the way that angular momentum is distributed in galaxies, it became clear to Fred that the Solar System's value for the angular momentum (per unit of mass) was correct for stars in elliptical galaxies; it was not correct for stars in the spiral arms of galaxies like our Milky Way. To be right for our Galaxy the Sun had to be a much older, so-called Population II star, which stars are mainly located in the Galactic bulge and halo. Pursuing this line of thinking would surely put the cat amongst the pigeons, but such considerations never deterred him. For many decades astronomers had been working on the assumption that the Sun was a so-called Population I star about 5×10^9 years old. Could the Sun really be a Population II star that is nearly 10×10^9 years old?

Fred Hoyle pointed out that the present appearance and state of the Sun is equally well explained for an older star if the starting conditions were different from what are generally assumed. In particular he pointed out that the initial ratio of helium to hydrogen was an arbitrary input in standard calculations that he himself had pioneered[4], and could be easily changed to produce a greater age of the Sun.

The only difficult sticking point, however, was the age of the Earth that all geologists without exception would swear to be $4{\cdot}5 \times 10^9$ years. That canonical age estimate is based mainly on radioactivity of surface rocks. The age could be wrong only if an impact event or events that happened $4{\cdot}5 \times 10^9$ years ago actually delivered the uranium-laden younger rocks. Similarly the well-attested ages of meteorites could also be explained. Later impacts at $4{\cdot}1 \times 10^9$ years ago would mark the inception of biology on the Earth[5,6]. The radioactive clocks from which ages of rocks are determined were set at the time of a more recent supernova event. Not impossible, but could perhaps be criticized as an artificial fix! Only by invoking the anthropic principle can that criticism be overcome. Yes, an accident it was, but if not for that accident we would not be here to talk about it! That was another example of the so-called anthropic principle that Fred had inaugurated in another context — a prediction of an excited level of the carbon nucleus[4].

Yours faithfully,
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The Heliographic Latitude of the Sunspot of 1676 June

The Maunder Minimum was an epoch with prolonged low solar activity which occurred during the second half of the 17th Century[1]. It is generally accepted that this phenomenon spanned the period 1645–1715, although some authors have proposed a redefinition of its extent[2]. That was the only grand minimum of solar activity registered during the telescopic era and it is of great interest for solar physics and geophysics owing to its importance for the behaviour of long-term solar activity and its influence on the climate of our planet[3,4].

Hoyt & Schatten[5] compiled a large number of observations corresponding to the Maunder Minimum, obtaining good temporal coverage. However, a part of those observations was obtained from solar meridian observations[6]. Recently, Vaquero *et al.*[7] have presented a revised collection of the sunspot group number based on the data-base of Hoyt & Schatten, including the observations corresponding to the Maunder Minimum. They have discarded those problematic observations located in Hoyt & Schatten's data-base and they have also added some new records. The level of solar activity during the Maunder Minimum is currently a controversial topic. Zolotova & Ponyavin[8]