Variable radioactive decay rates and the changes in solar activity

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Recent research by physicists has suggested that there is some correlation between changes in solar activity and radioactive decay rates. Jere Jenkins and Ephraim Fischbach (from Purdue University, Indiana), for instance, have found that there appears to be a correlation between the radioactive decay rate of ^{32}Si and ^{226}Ra on the earth and changes relating to the sun's activity. This is an important area of research for those who question the constancy of radioactive decay rates, and such variable decay rates may have a bearing upon our understanding of the dating of various rock layers.[1]

The growing evidence

Discrepancies in the radioactive decay of ^{32}Si and ^{226}Ra on the earth's surface seem to show a degree of correlation with the annual cycle of the earth's orbit around the sun; that is between aphelion and perihelion with rates speeding up as the earth gets closer to the sun and decreasing as it moves away (data was gathered by the Brookhaven National Laboratory for the beta decay of ^{32}Si and the Physikalisch-Technische-Bundesandstalt in Germany for the alpha decay of ^{226}Ra).[2] The ^{32}Si data was supplied by David Alburger, who had observed anomalies in the decay rate of this isotope through work carried out in 1986. The decay rate seems to be fastest in January–February with a low point in July–August.[3] This seems to correlate with a small time lag, or phase shift, between the distance between the sun and earth, and is as yet unexplained. Of course the changes observed in decay rates is small, perhaps of the order of less than 1 percent over the annual cycle, but then any changes in the distance from Earth to the sun is also relatively small.

In another study a sample of ^{54}Mn was found to vary with the occurrence of a significant X-ray solar flare (level X3) and a high-energy solar proton storm (raised flux levels at >10 MeV protons) on 13 December 2006, and a similar correlation was seen in relation to a weaker X-ray flare on 17 December 2006.[4] Furthermore, with the 13 December event the variation in decay rates began to change some 36 to 40 hours prior to the X-ray flare. However, it is noteworthy that the observed decay rate seems to have reduced with the flare, whereas the decay rate in the previous findings increased with closer proximity to the sun, as Barry Setterfield for instance has pointed out.[5] The authors suggest that it is unlikely that instrument error is the cause of the differences.

Peter Sturrock of Stanford University has also found that there is evidence of a correlation with the 33-day period spin of the solar core and decay rates of ^{32}Si and ^{36}Cl.[6] Sturrock points out that one side of the sun's inner core emits neutrinos more strongly than the other, and from this accumulating evidence, he has proposed that changes in neutrino flux differences may have some impact upon the rate at which some radioactive isotopes decay. However, this is controversial because neutrinos are notoriously unreactive and difficult to detect, and decay rates are supposed to be unresponsive to change as Jenkins points out. Why would something apparently so weak affect something so stable? In later work, Fischbach, Jenkins, and Sturrock proposed the existence of a new particle called the *neutrello*, which in many respects is the same as the neutrino, but differs in its ability to interact with radionuclei.[7] Setterfield also points out that if neutrino flux density is the cause then that should have shown up in the decay rates of radioactive material onboard various space probes that have traversed into lower and higher orbits.[5] Therefore neutrinos would not be the obvious candidate for a causal link.[2,4]

Further discussion

Jenkins and Fischbach have discounted geo-magnetic disturbances as a possibility due to lack of correlation, although they have not considered the fact that the solar event of 13 December 2006 also led to a ground-level neutron event (GLE) that may have led to changes in the decay rate of their sample.[8] Very high-energy solar proton storms (with raised flux levels at > 100 MeV proton energy level) may increase the background count of neutrons at ground level as secondary products, particularly in high latitudes. However, these events are relatively short-lived, a matter of a few hours, compared to the length of anomaly found in Jenkins and Fischbach's study, and it occurred after the decrease in decay rates had begun. A related possibility is the effect of a Forbush decrease on radioactive decay rates. The increase in the high-energy solar proton flux acts in opposition to the flow of cosmic gamma rays, but again the observed decrease in decay rates happened prior to the start of the proton storm. Instead, if there is a correlation it might tie in with the developing sunspot's magnetic complexity, the tension of which builds up prior to the release of a coronal mass ejection and emission of X-ray flares and associated high-energy proton storms. But as the research suggests, there seems to be changes taking place on or within the sun that precede the flare.

An alternative explanation, however, might be related to differences in the scalar energy field density in the vacuum of space (sometimes called zero point energy or the cosmological constant and observed as the Casimir effect—also related to theories of quantum gravity). The zero point energy is the energy left over in a thermodynamic system when it is reduced to absolute zero (it is equal

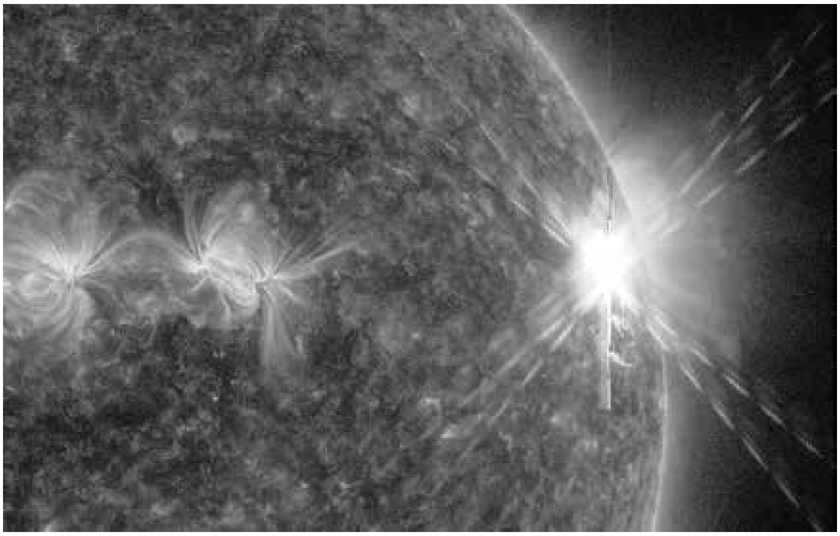
Photo: NASA

Figure 1. NASA SDO satellite image (AIA 131) of an X6.9 flare on 9 August 2011 at 3:48 pm EDT.

to ½ hf, where f is the frequency and h is Plank's Constant). Barrow and Shaw for instance have proposed that the sun's mass may modify this scalar field ϕ and that changes in the gradient of the field might be the cause of the annual variation in radioactive decay rates of isotopes on earth, as the radius of the earth's orbit varies in distance over the year. Their proposal is that the electromagnetic fine-structure constant α_{EM} is in fact sensitive to changes in the scalar field, and so affects alpha and beta decay rates.[9] However, Jenkins and Fischbach doubt whether variations in the fine-structure constant alone are large enough to account for their findings, although they suggest coupling from two different scalar fields to α_{EM} and to the electron-proton ratio M_e/M_p may have a larger impact upon decay rates. Setterfield also favours an explanation involving changes in the density of the zero point energy field that exists in the vacuum of space. He has suggested that the movement of the solar system as a whole through space against this field, and the earth's motion relative to this, might help to explain the phase shift between the aphelion-perihelion cycle and the variation in radioactive decay rates.

The rate of change found so far is, however, really quite small, and not of the order of magnitude that would immediately benefit creation science, although it does offer the possibility of fruitful future research, particularly the possibility of sensitivity between the fine-structure constant and radioactive decay rates. If it is possible to find a way of accounting for larger disturbances in the scalar energy field, perhaps through amplification of longitudinal waves that modify its density, or constructive/destructive interference of separate waves forms in this field, then that might offer one possibility for accelerated or decelerated decay rates. Tentative possibilities might be related to gravity waves or the shock wave from a supernova explosion for instance.

Summary

This recent work provides a glimpse into an area of research that may provide fruitful outcomes for those with an interest in creation science, particularly the variability of radioactive decay rates. Although at present the identified size of changes are quite small, there are perhaps early observational indications that larger changes in decay rates are possible. Future theoretical and observational research may uncover such possibilities. Solutions involving neutrinos do not appear to offer sufficient energetic interaction to be credible, although further research will shed light on this. However, research into the effect of scalar energy fields may offer another way forward. This may also help provide an explanation for rates of helium diffusion and the production of radio-haloes found in zircon crystals, the radioactive decay rate of which is discussed by the RATE team.[10]

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