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ORIGINAL ARTICLE

Solar influence on nuclear decay rates: constraints from the MESSENGER mission

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Abstract We have analyzed ^{137}Cs decay data, obtained from a small sample onboard the MESSENGER spacecraft en route to Mercury, with the aim of setting limits on a possible correlation between nuclear decay rates and solar activity. Such a correlation has been suggested recently on the basis of data from ^{54}Mn decay during the solar flare of 13 December 2006, and by indications of an annual and other periodic variations in the decay rates of ^{32}Si, ^{36}Cl, and ^{226}Ra. Data from five measurements of the ^{137}Cs count rate over a period of approximately 5.4 years have been fit to a formula which accounts for the usual exponential decrease in count rate over time, along with the addition of a theoretical solar contribution varying with MESSENGER-Sun separation. The indication of solar influence is then characterized by a non-zero value of the calculated parameter ξ, and we find $\xi = (2.8 \pm 8.1) \times 10^{-3}$ for ^{137}Cs. A simulation of the increased data that can hypothetically be expected following Mercury orbit insertion on 18 March 2011 suggests that the anticipated improvement in the determination of ξ could reveal a non-zero value of ξ if present at a level consistent with other data.

Keywords Astroparticle physics · Nuclear reactions · Sun: particle emission

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In a recent series of papers (Jenkins and Fischbach 2009; Jenkins et al. 2009; Fischbach et al. 2009; Sturrock et al. 2010a; Javorsek II et al. 2010; Sturrock et al. 2010b) evidence has been presented for a possible solar influence on nuclear decay rates. Data analyzed by Jenkins and Fischbach (2009) and Fischbach et al. (2009) indicate a possible correlation between the solar flare of 13 December 2006 and a decrease in the measured decay rate of ^{54}Mn coincident in time with the flare. An analysis of data from Brookhaven National Laboratory (BNL) on the measured decay rates of ^{32}Si and ^{36}Cl, and from the Physikalisch-Technische Bundesanstalt (PTB) in Germany on the measured decay rates of ^{226}Ra and its daughters, show that both data sets exhibit similar annual variations in their respective decay rates (Jenkins et al. 2009; Fischbach et al. 2009). Similar periodic effects have been reported by Parkhomov and Maklyaev (2004), Parkhomov (2005, 2010b, 2010c, 2010d), Ellis (1990), Falkenberg (2001), Baurov et al. (2001, 2007), and more recently by Jenkins et al. (2011, submitted), in data from The Ohio State University. In addition to annual periodicities, evidence for other periodicities in decay data possibly associated with solar rotation is reported in Sturrock et al.(2010a, 2010b), Fischbach et al. (2011), and Sturrock et al. (2011), including evidence for a period of ∼33 days, and for a 2.11 yr^{-1} Rieger-like periodicity. Since none