Cosmic ray intensity variation on the time scale of million years?

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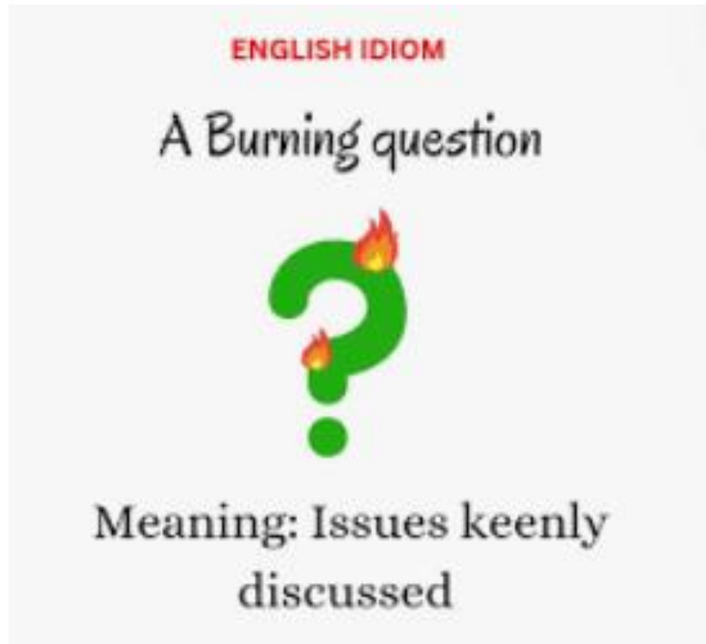
A burning questing haunting us….



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The Galactic Cosmic Ray Intensity over the Past 10^6–10^9 Years as Recorded by Cosmogenic Nuclides in Meteorites and Terrestrial Samples

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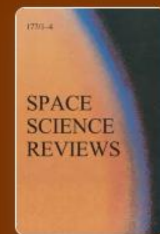

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Abstract Concentrations of stable and radioactive nuclides produced by cosmic ray particles in meteorites allow us to track the long term average of the primary flux of galactic cosmic rays (GCR). During the past ~10 Ma, the average GCR flux remained constant over timescales of hundreds of thousands to millions of years, and, if corrected for known variations in solar modulation, also during the past several years to hundreds of years. Because

so far so good…but

ations in solar modulation, also during the past several years to hundreds of years. Because the cosmic ray concentrations in meteorites represent integral signals, it is difficult to assess the limits of uncertainty of this statement, but they are larger than the often quoted analytical and model uncertainties of some 30%. Time series of concentrations of the radionuclide

But

4 The GCR Flux over the Past ~10 Million Years—Evidence from ^{10}Be in Terrestrial Samples

Concentrations of cosmogenic ^{10}Be as a function of depth or deposition time are being measured in ice cores (Beer et al. 2011, this issue), as well as in marine sediments and slowly growing iron-manganese crusts, often in conjunction with stable ^{9}Be (Ku et al. 1982;

cal and model uncertainties of some 30%. Time series of concentrations of the radionuclide ^{10}Be in terrestrial samples strengthen the conclusions drawn from meteorite studies, indicating that the GCR intensity on a ~0.5 million year scale has remained constant within some ±10% during the past ~10 million years. The very long-lived radioactive nuclide ^{40}K

What are the consequence for us ?

Since long I/we have suspected that flux changes in the past will somehow be damped by the fact that they affects both Be and Al in the same way....but
I/we never came to really check this....

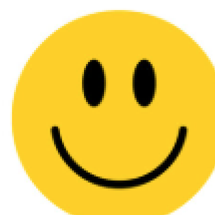
I did an attempt the other day........

Result for the simple burial method
I used as an example samples from Tebogo

Neutron flux	-20%	-10%	Nominal	+10%	+20%
Sample 1 (Burial time Million years)	1.60 (-3.0%)	1.63	1.65	1.67	1.69 (+2.4%)
Sample 2	2.62	2.65	2.68	2.71	2.74
Sample 3	3.79 (-2.1%)	3.83	3.87	3.91	3.95 (+2.1%)
Sample 4	2.52	2.55	2.58	2.61	2.64
Sample 5	2.28 (-2.5%)	2.31	2.34	2.36	2.39 (+2.1%)

Very encouraging……

1-1.5 % in burial time for each 10% uncertainty in the cosmic flux..



Compare with just changing the cross section for e.g. creating Al ^{26}

Cross section for Creating Al^{26}	-10%	Nominal	+10%
Sample 1 (Burial time Million years)	1.46 (-11.5 %)	1.65	1.84 (+11.5%)
Sample 2	2.50	2.68	2..86
Sample 3	3.70 (-4.3%)	3.87	4.04 (+4.3%)
Sample 4	2.40	2.58	2.76
Sample 5	2.15 (-.8.1 %)	2.34	2.52 (+7.7%)

Roughly 10 times bigger effect and here the absolute value is the same independent of the burial time… that's why we have different effects on the different samples

Important Caveat

We have assumed that it is only the intensity of the cosmic rays that changes on the Million Year timescale and not the energy spectrum

As far as I understand this is also the assumption made in the meteorite and terrestrial studies of the constancy of cosmic rays

Consequence for the neutron flux measurements

Observe that the table below also tells us is that no point to measure the neutron flux with a precision better than 10%

Neutron flux	-20%	-10%	Nominal	+10%	+20%
Sample 1 (Burial time Million years)	1.60 (-3.0%)	1.63	1.65	1.67	1.69 (+2.4%)
Sample 2	2.62	2.65	2.68	2.71	2.74
Sample 3	3.79 (-2.1%)	3.83	3.87	3.91	3.95 (+2.1%)
Sample 4	2.52	2.55	2.58	2.61	2.64
Sample 5	2.28 (-2.5%)	2.31	2.34	2.36	2.39 (+2.1%)

Conclusion

Time variation of the cosmic flux of neutrons
of the order of 10 % will have an 1% effect
on the calculated burial time.

We don't need to measure the neutron flux
to better than about 10 %

Caveat: It is assumed that it is only the flux intensity
and not the spectrum that changes at the time scale
of Million of years

Back up