Cosmic Maximus?

Using a Scintillator Counter to Evaluate the Sun's Contribution to Cosmic Radiation

A Simple Study Conducted as Part of the PAN Project held at the NSCL of the Michigan State University July 30 - August 3, 2012

William Heeren

Partners... James Harvey and Manju Prakash
Cosmic Maximus?

To Be Tested... If the Sun contributes a large fraction of the cosmic radiation, then cosmic radiation levels should be higher during the day than at night.

http://scienceblogs.com/startswithabang/2010/03/21/weekend-diversion-a-little-sun/
Primary Cosmic Radiation

Particles from
- The Sun
- Various Supernova
- Other Extraterrestrial Sources

- Traveling at very high speeds
- Constantly raining down on Earth's surface

- Rarely does primary cosmic radiation reach the Earth's surface
Cosmic Ray Air Showers

- Particles collide with other atmospheric particles producing an assortment of particles

- A high energy cosmic ray (proton) can initiate billions of collisions producing air showers many tens of kilometers in area

http://www.particle.kth.se/SEASA/
http://www.theresilientearth.com/?q=content/attempt-discalcredit-cosmic-ray-climate-link-using-computer-model
Some Important Cosmic Ray Collisions

\[ n + ^{14}\text{N} \rightarrow p + ^{14}\text{C} \]  
Formation of C-14

\[ ^{14}\text{N} + n \rightarrow ^{12}\text{C} + 3\text{T} \]  
Formation of tritium (H-3)

\[ ^{16}\text{O} + n \rightarrow ^{10}\text{Be} + {}^4\alpha + 2^1p + n \]  
Formation of Be-10

http://www.particle.kth.se/SEASA/
http://www.theresilientearth.com/?q=content/atempt-discredit-cosmic-ray-climate-link-using-computer-m
http://en.wikipedia.org/wiki/Cosmic_rayodel
Cosmic Ray Air Showers
Breakdown into more elementary particles

Primary cosmic radiation

Secondary cosmic radiations

Top of the atmosphere

Protons (p)
Neutral pions ($\pi^0$)
Charged pions ($\pi^+$, $\pi^-$)
Muons (μ)
Neutrinos (ν)
Electrons, positrons, gamma rays (e, γ)

http://physics.aps.org/assets/d22f9a3393df823f
Some Decay Reactions

proton + neutron $\rightarrow$ proton + proton + charged pions

charged pions $\rightarrow$ muons + neutrinos

proton + neutron $\rightarrow$ proton + neutron + uncharged pions

uncharged pions $\rightarrow$ gamma rays

http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf
Secondary Cosmic Radiation

Some Decay Reactions

\[ p + n \rightarrow p + p^+ \pi^{+/−} \]
\[ \pi^{+/−} \rightarrow \mu^+ \nu \]
\[ p + n \rightarrow p + n + \pi^0 \]
\[ \pi^0 \rightarrow \gamma \]

http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf
Secondary Cosmic Radiation

Some Decay Reactions

\[ \text{muons}^- \rightarrow \text{electrons} + \text{antinelectron neutrinos} + \text{muon neutrinos} \]

\[ \mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu \]

Muons are the usual form of cosmic radiation that reaches the Earth.

http://en.wikipedia.org/wiki/Muon#Muon_decay
Muons are the usual form of cosmic radiation that reaches the Earth.

http://en.wikipedia.org/wiki/Muon#Muon_decay
Secondary Cosmic Radiation

Incidence

At the Earth's surface, a rough estimate is that in one second there are 1-2 muons passing through your hand.

http://www18.i2u2.org/cosmic/library/upload/3/3f/6000CRMD_How_to_Plateau.ppt
Secondary Cosmic Radiation Detection

On a large scale, cosmic air showers can be measured by arrays of detectors placed strategically at different parts of the Earth’s surface.
Secondary Cosmic Radiation Detection

On a small scale, the rate, direction and energy of cosmic radiation can be measured by using a cosmic ray detector such as this...

http://cosmic.lbl.gov/documentation/CosmicDetector2-0.pdf
Secondary Cosmic Radiation

Detection

Charged cosmic rays excite atoms in scintillator panels (often Plastic Lucite panels), causing the atoms to emit light. The light is directed to photomultiplier tubes which amplify the signal.
To Be Tested... If the Sun contributes a large fraction of the cosmic radiation, then cosmic radiation levels should be higher during the day than at night.

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- Using a Scintillator Counter, take three different sets of cosmic radiation data: at 9:00PM, 5:00AM, 1:00PM
- Several three minute test samples will be taken during each interval.
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Scintillation Count at 5:00 AM

Average 209

Scintillation Count at 1:00 PM

Average 327

Scintillation Count at 9:00 PM

Average 314

http://www.swpc.noaa.gov/primer/primer.html
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Notice that the averages all fit within the error ranges shown.

The Data

Scintillation Counts At Various Times During The Day
July 31, 2012-August 1, 2012

Average 314

Average 308

Average 322
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Analysis

The average of each time period is within the range of the other time periods as well.
We **cannot** conclude that the cosmic radiation levels are higher during the day than they are during the night. This agrees with other sources that suggest very little (0.2% Blanco, et.al.) differences exist between the amounts of cosmic radiation reaching the Earth at various times of the day.

http://oldweb.ct.infn.it/~rivel/cosmic/Documents/Publications/NOVA_Publisher.pdf
The End...
(A Supernova has occurred.... :-)

Aug 7-3:28 PM