

# 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**

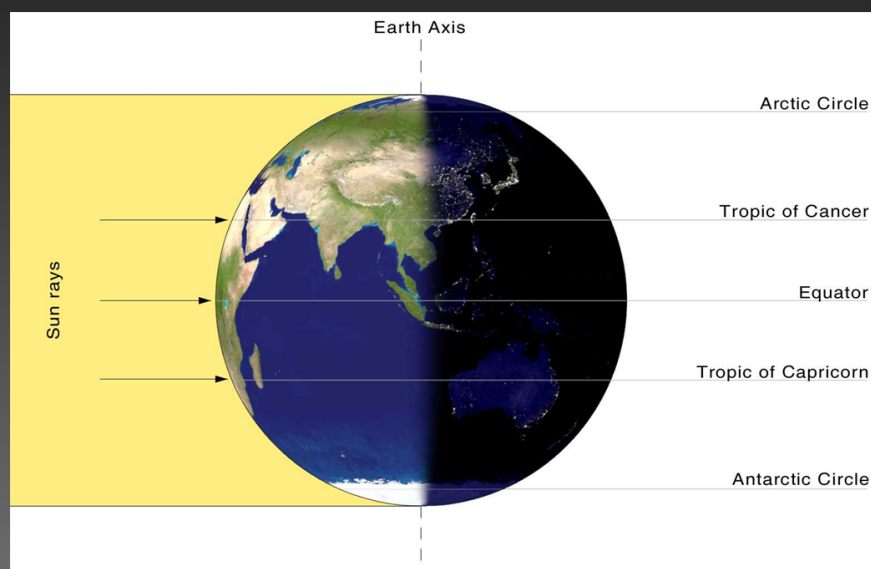
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Partners... **James Harvey** and **Manju Prakash**



# 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/>

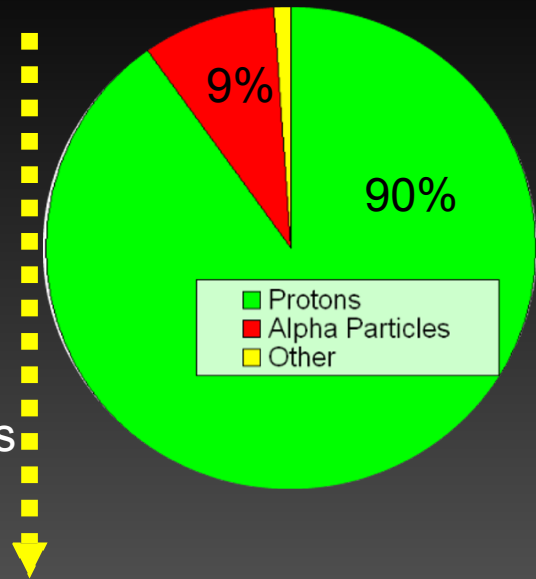
# Primary Cosmic Radiation

Background

Particles from

- The Sun
- Various Supernova
- Other Extraterrestrial Sources

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

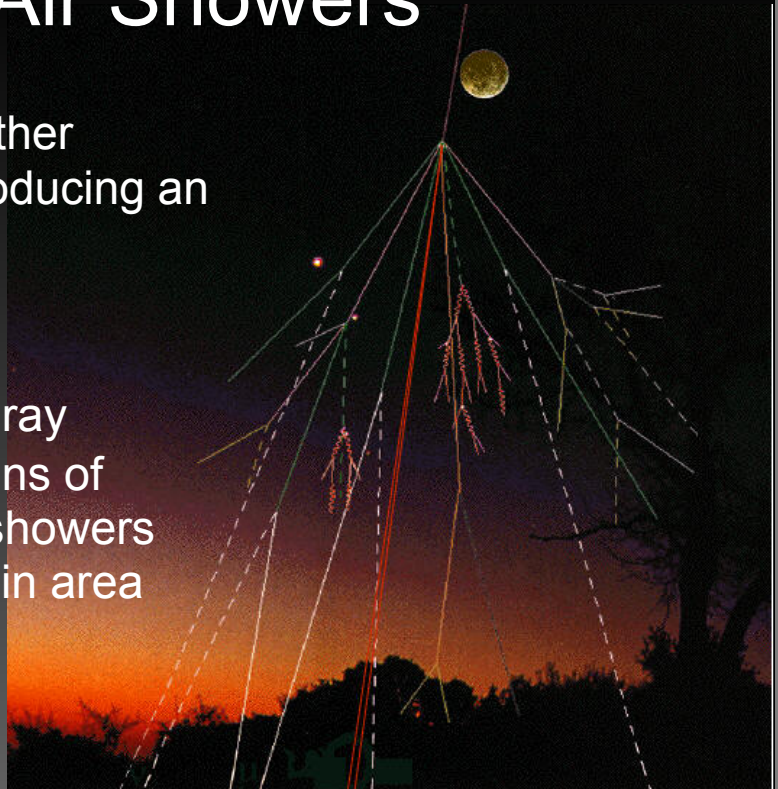


- Rarely does primary cosmic radiation reach the Earth's surface

# Cosmic Ray Air Showers

Background

- 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

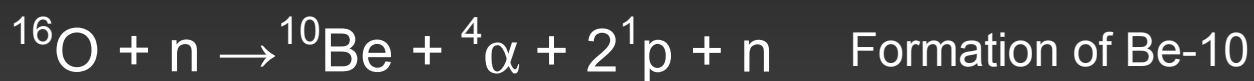


<http://www.particle.kth.se/SEASA/>  
<http://www.theresilientearth.com/?q=content/attempt-discredit-cosmic-ray-climate-link-using-computer-model>



Background

## Some Important Cosmic Ray Collisions



<http://www.particle.kth.se/SEASA/>

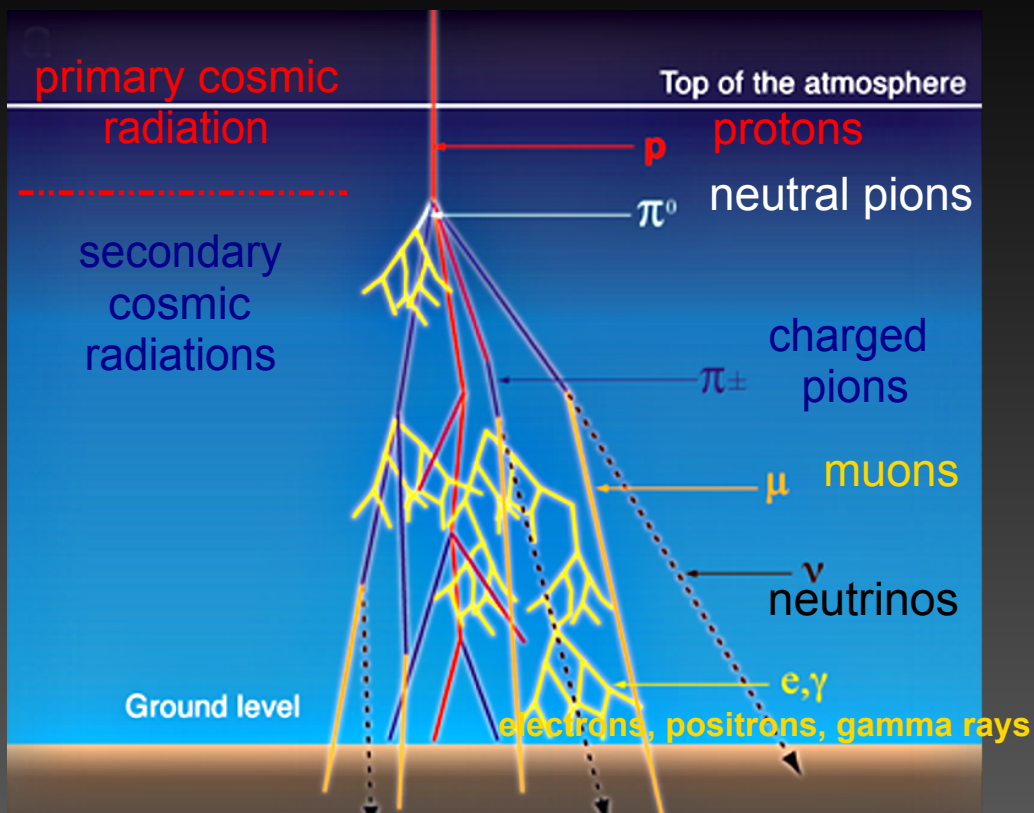
<http://www.theresilientearth.com/?q=content/attempt-discredit-cosmic-ray-climate-link-using-computer-m>

[http://en.wikipedia.org/wiki/Cosmic\\_rayodel](http://en.wikipedia.org/wiki/Cosmic_rayodel)

# Cosmic Ray Air Showers

Breakdown into more elementary particles

Background



<http://physics.aps.org/assets/d22f9a3393df823f>

Secondary Cosmic Radiation

Background

## Some Decay Reactions

proton + neutron  $\longrightarrow$  proton + proton + charged pions

charged pions  $\longrightarrow$  muons + neutrinos

proton + neutron  $\longrightarrow$  proton + neutron + uncharged pions

uncharged pions  $\longrightarrow$  gamma rays

<http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf>

## Secondary Cosmic Radiation

Background

# Some Decay Reactions



<http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf>



## Secondary Cosmic Radiation

Background

# Some Decay Reactions

muons<sup>-</sup>

electrons + antielectron neutrinos + muon neutrinos



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

[http://en.wikipedia.org/wiki/Muon#Muon\\_decay](http://en.wikipedia.org/wiki/Muon#Muon_decay)

## Secondary Cosmic Radiation

Background

# Some Decay Particles

Particle	Lifetime (seconds)	Composition
neutron	881.5	3 quarks (1 up and two down quarks)
pion	$2.6 \times 10^{-8}$	2 quarks (up or down quark and an anti up or down quark)
muons	$2.2 \times 10^{-6}$	Elementary particle

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

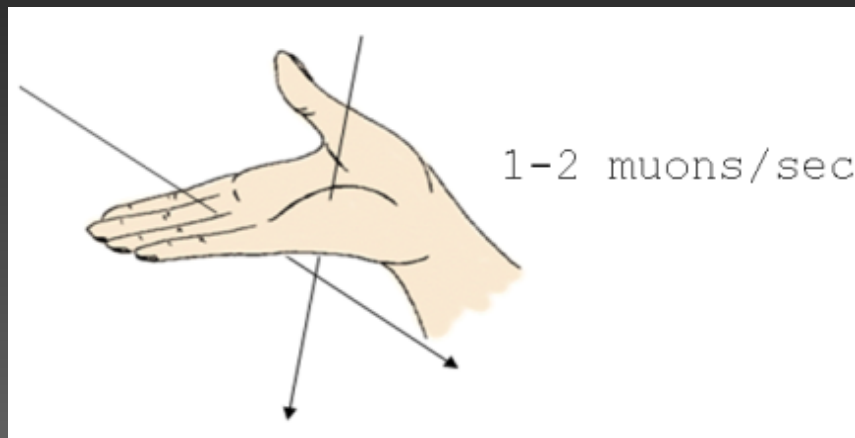
[http://en.wikipedia.org/wiki/Muon#Muon\\_decay](http://en.wikipedia.org/wiki/Muon#Muon_decay)

## Secondary Cosmic Radiation

Background

# Incidence

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



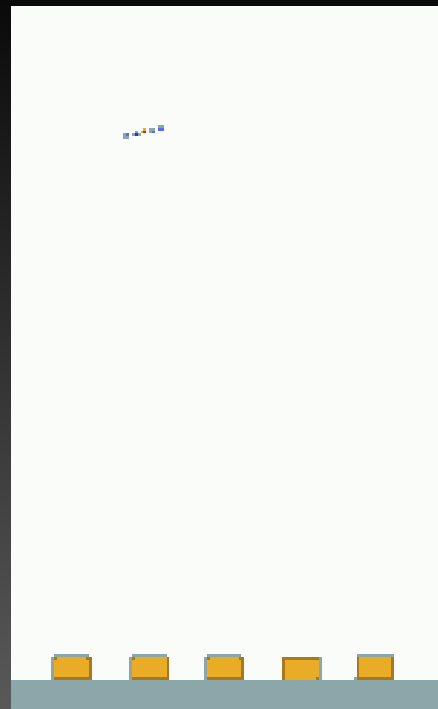
[http://www18.i2u2.org/cosmic/library/upload/3/3f/6000CRMD\\_How\\_to\\_Plateau.ppt](http://www18.i2u2.org/cosmic/library/upload/3/3f/6000CRMD_How_to_Plateau.ppt)

## Secondary Cosmic Radiation

Background

# 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



 <http://www.particle.kth.se/SEASA/#rain>

## Secondary Cosmic Radiation

Background

## 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...



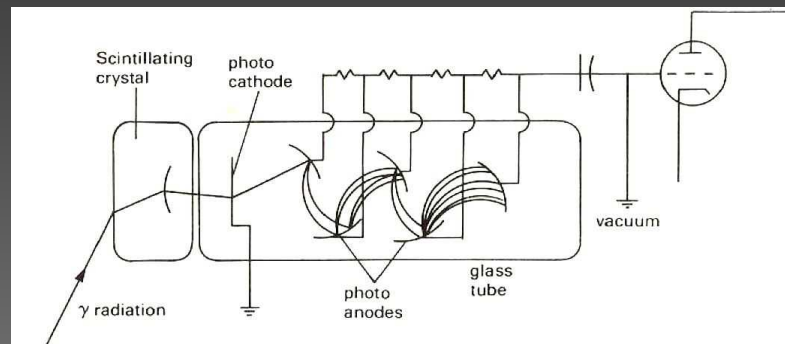
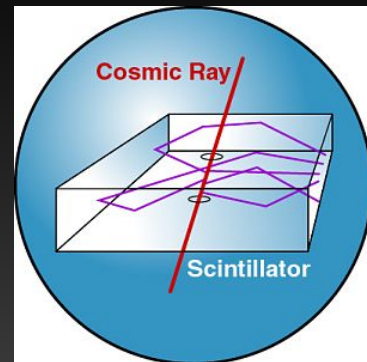
<http://cosmic.lbl.gov/documentation/CosmicDetector2-0.pdf>

## Secondary Cosmic Radiation

Background

## 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.



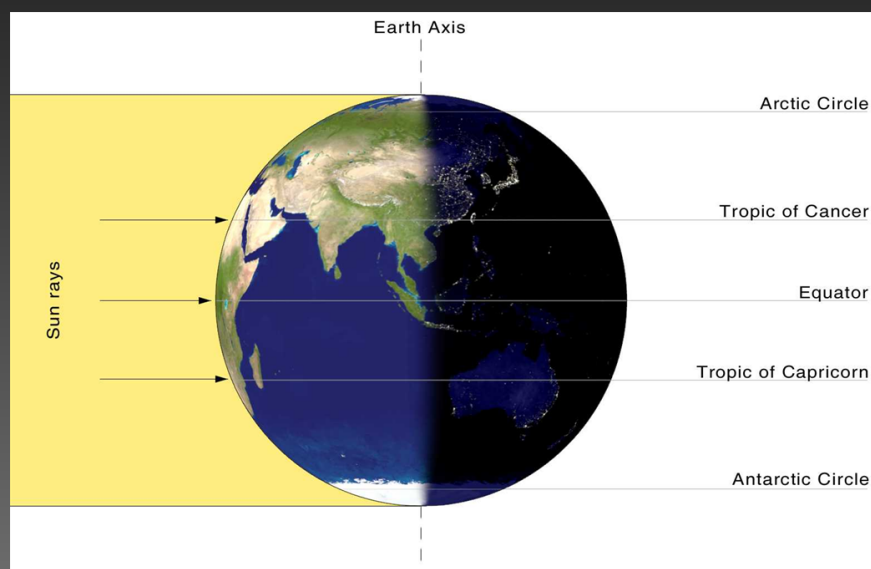
<http://durpdg.dur.ac.uk/vvc/cosmicrays/images/scintillator2.jpg>  
<http://2.bp.blogspot.com/-sVtZGzU7Bb8/TigHts4EYKI/AAAAAAAAAWs/14I-Rxy1Ys1600/scintillation+chamber.JPG>



# Cosmic Maximus?

The Test

**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/startwithabang/2010/03/21/weekend-diversion-a-little-sun/>

# Cosmic Maximus?

The Test

- 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.



View from the test site



The Scintillator Counter

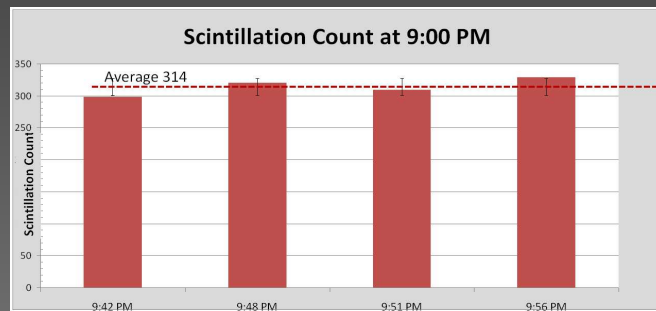
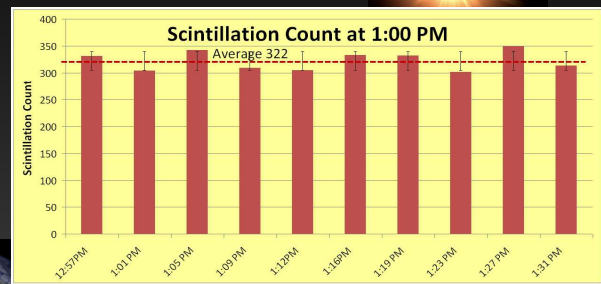
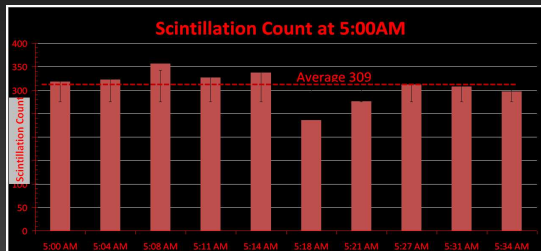


View of one of the scintillating panels wrapped in aluminum foil



# Cosmic Maximus?

The Data

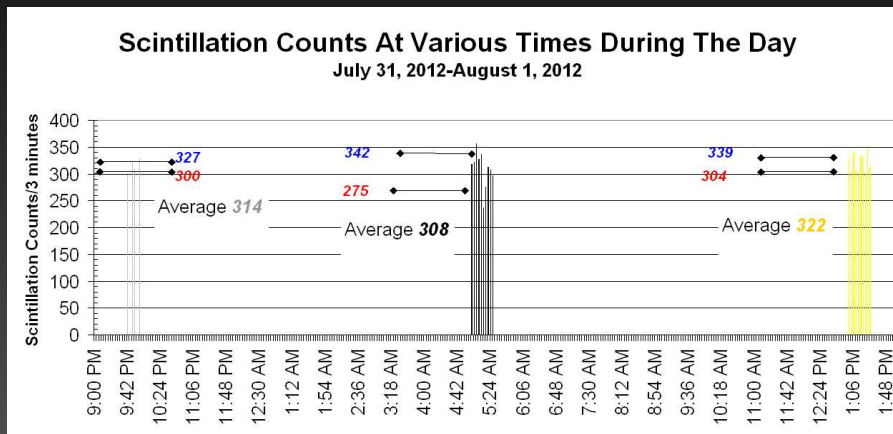


<http://www.swpc.noaa.gov/primer/primer.html>



# Cosmic Maximus?

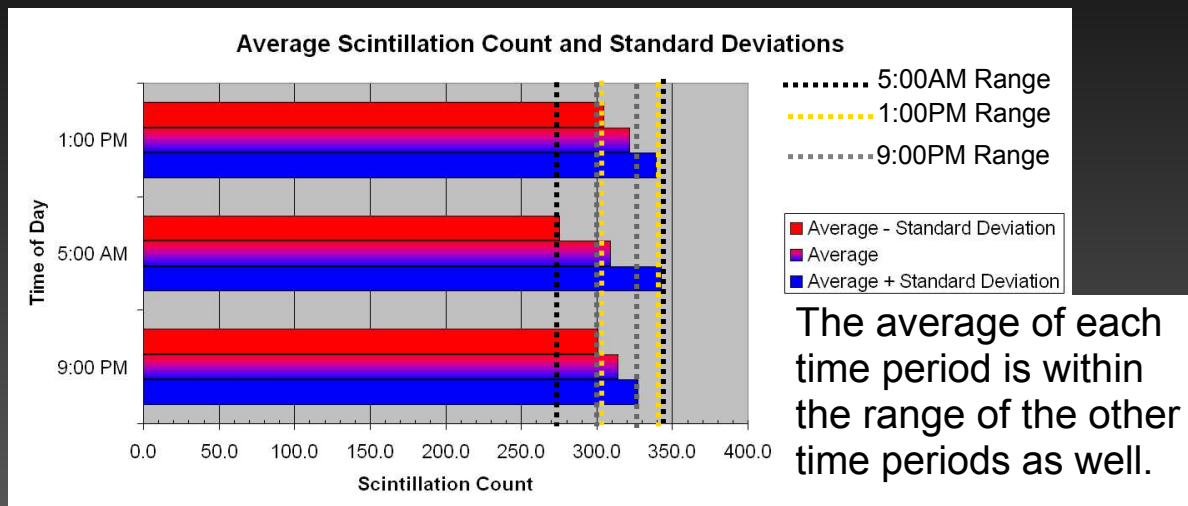
The Data



Notice that the averages all fit within the error ranges shown

# Cosmic Maximus?

Analysis



# Cosmic Consistentus?

Conclusion

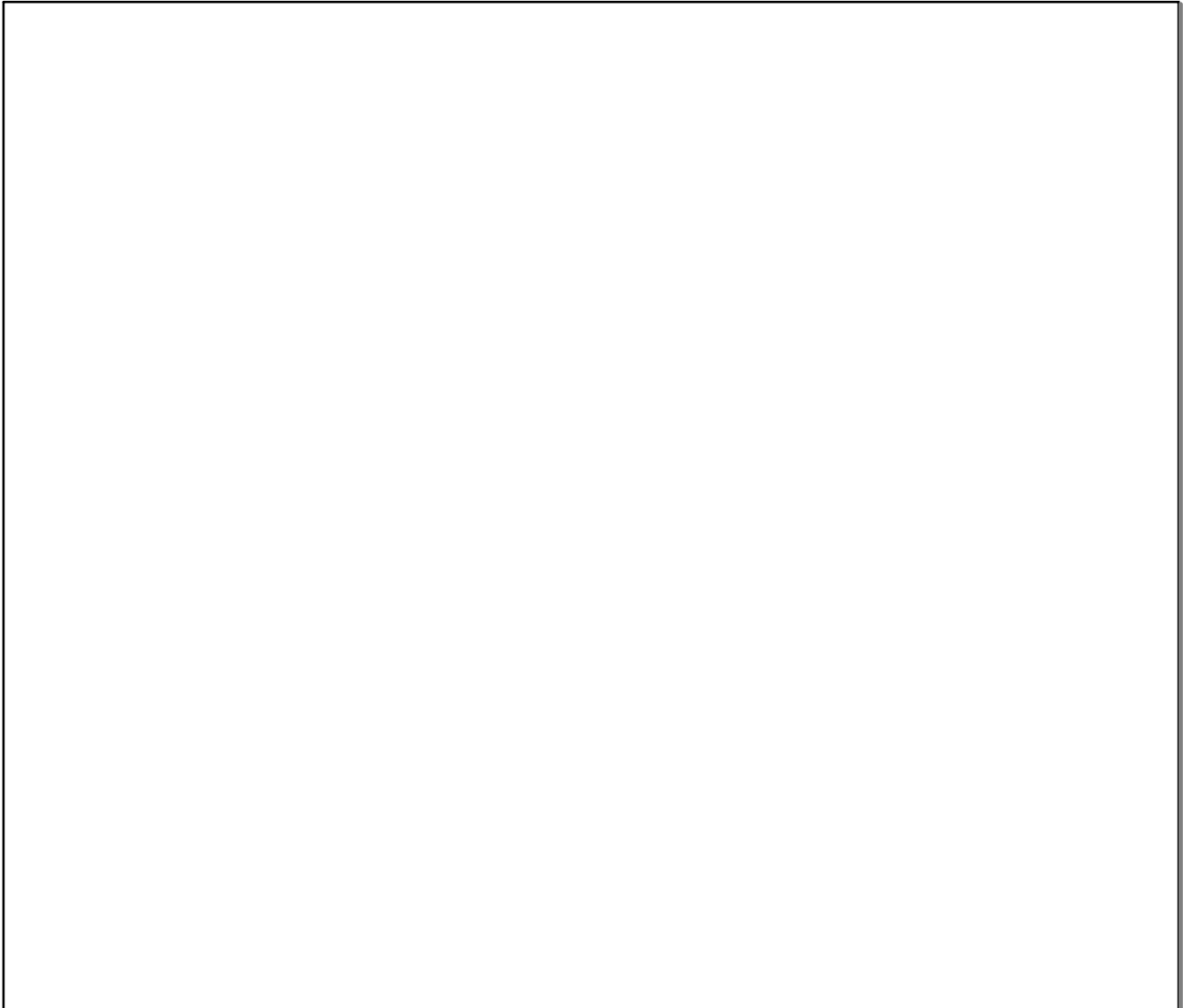
We **cannot** conclude that the cosmic radiation levels are higher during the day than they are during the night. This agrees with other sources that suggest very little (0.2% Blanco, et.al.) differences exist between the amounts of cosmic radiation reaching the Earth at various times of the day.



<http://www.eurekalert.org/multimedia/pub/2413.php?from=86777>  
[http://oldweb.ct.infn.it/~rivel/cosmic/Documents/Publications/NOVA\\_Publisher.pdf](http://oldweb.ct.infn.it/~rivel/cosmic/Documents/Publications/NOVA_Publisher.pdf)

The End...

(A Supernova has occurred.... :-)



Aug 8-7:25 PM