

# Cosmic Maximus?

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

[http://en.wikipedia.org/wiki/Atmosphere\\_of\\_Earth](http://en.wikipedia.org/wiki/Atmosphere_of_Earth)

[http://en.wikipedia.org/wiki/Atmosphere\\_of\\_Earth](http://en.wikipedia.org/wiki/Atmosphere_of_Earth)

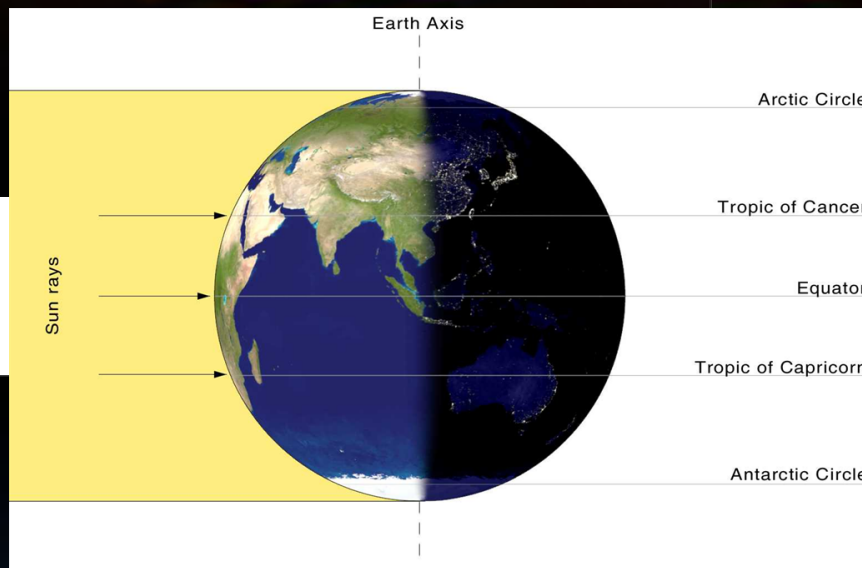
**A Simple Study Conducted as Part of the PAN Project held at the NSCL of the Michigan State University July 30 - August 3, 2012**  
**William Heeren**

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.



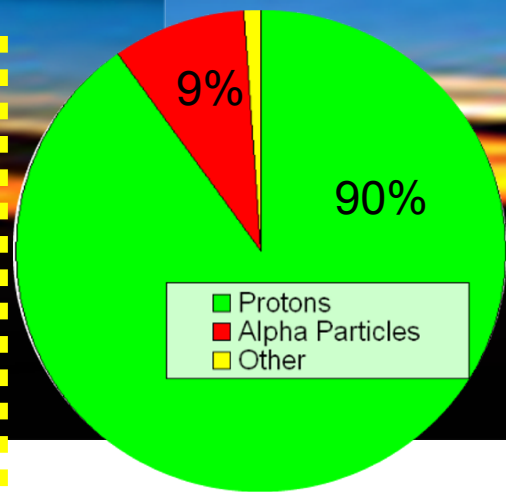
<http://scienceblogs.com/startswithabang/2010/03/21/weekend-diversion-a-little-sun/>

# Primary Cosmic Radiation

Particles from

- the Sun
- Various Supernova
- Other Extraterrestrial Sources

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

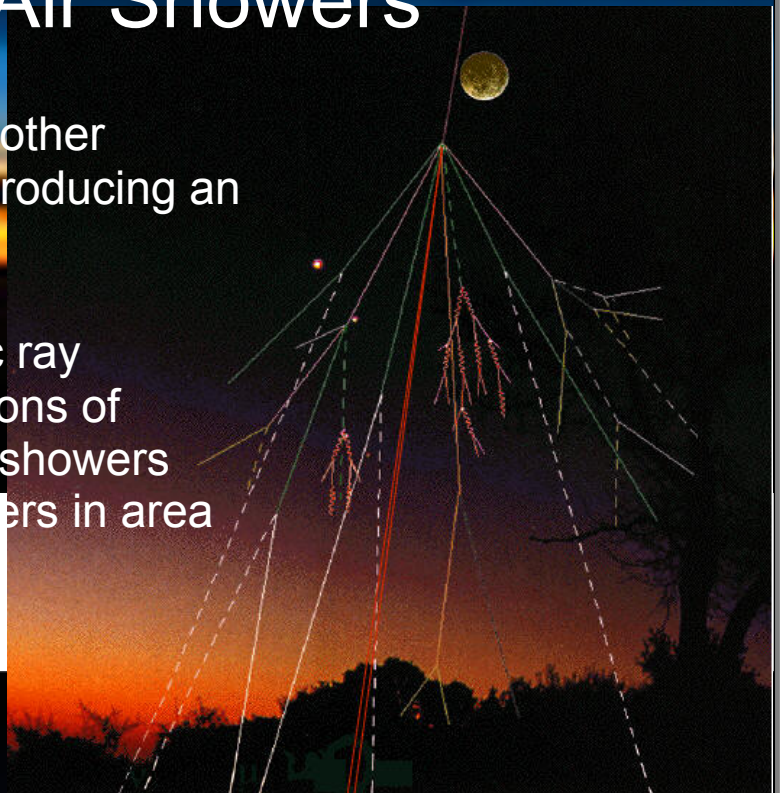


- Rarely does primary cosmic radiation reach the Earth's surface

# Cosmic Ray Air Showers

Background

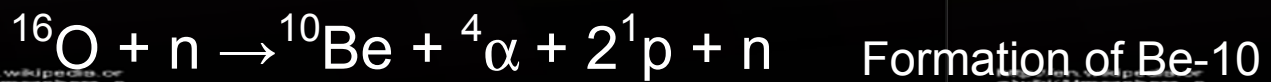
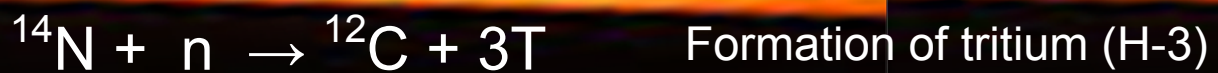
- Particles collide with other atmospheric particles producing an assortment of particles
- A high energy cosmic ray (proton) can initiate billions of collisions producing air showers



<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/>

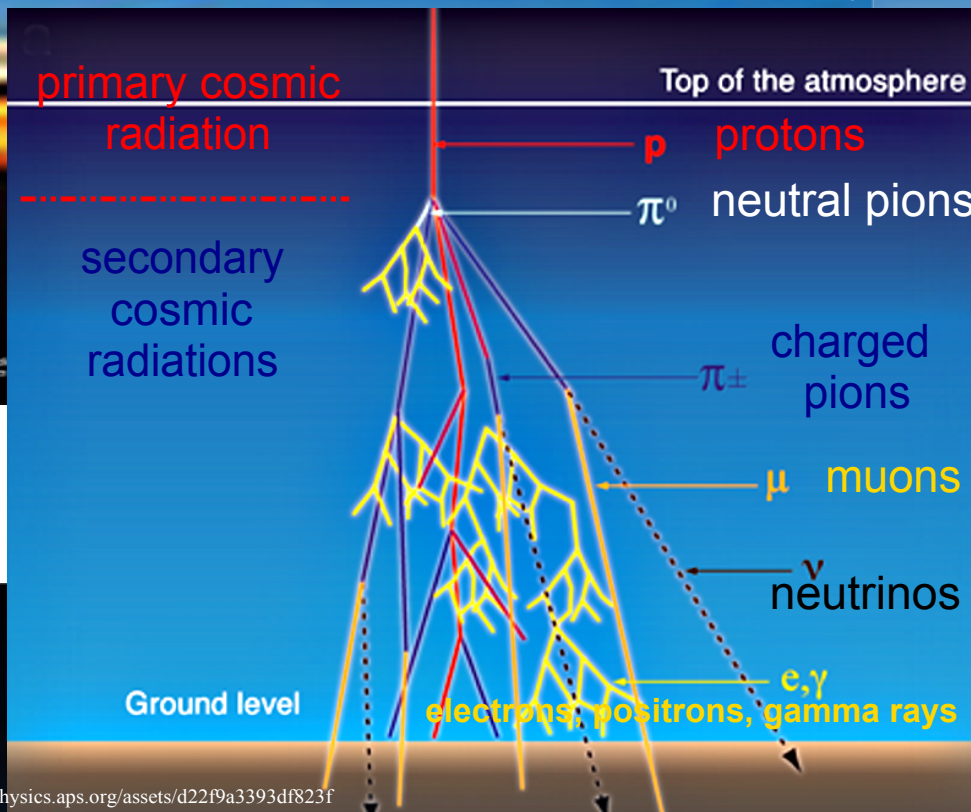
<http://www.theresilientearth.com/?q=content/attempt-discredit-cosmic-ray-climate-link-using-computer-m>

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


Background

# Cosmic Ray Air Showers

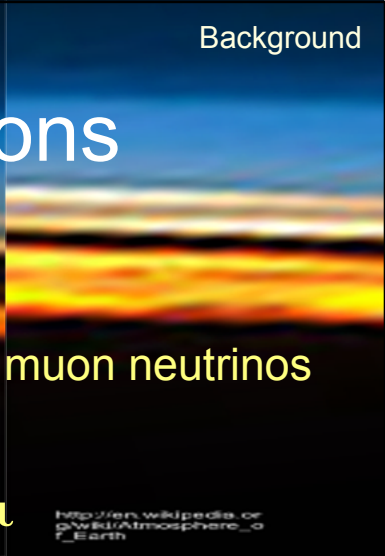
Breakdown into more elementary particles



<p>Secondary Cosmic Radiation</p> <h1>Some Decay Reactions</h1> <p>proton + neutron <math>\longrightarrow</math> proton + proton + charged pions charged pions <math>\longrightarrow</math> muons + neutrinos</p> <p>proton + neutron <math>\longrightarrow</math> proton + neutron + uncharged pions</p> <p><small>wikipedia.org atmosphere_3</small></p>	<p>Background</p> <p><small>q/wiki/Atmosphere_of_Earth</small></p>
<p>uncharged pions <math>\longrightarrow</math> gamma rays</p>	
<p><a href="http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf">http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf</a></p>	

<p>Secondary Cosmic Radiation</p> <h2>Some Decay Reactions</h2> $p + n \longrightarrow p + p + \pi^{+/-}$ $\pi^{+/-} \longrightarrow \mu + \nu$ $p + n \longrightarrow p + n + \pi^0$ <p><small>http://en.wikipedia.org/wiki/Atmosphere_of_Earth</small></p>	<p>Background</p> 
$\pi^0 \longrightarrow \gamma$	
<p><small>http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf</small></p>	



<p>Secondary Cosmic Radiation</p> <h2>Some Decay Reactions</h2> <p>muons<sup>-</sup> → electrons + antielectron neutrinos + muon neutrinos</p> $\mu^{-} \longrightarrow e^{-} + \bar{\nu}_e + \nu_{\mu}$ <p><small>http://en.wikipedia.org/wiki/Atmosphere_of_Earth</small></p>	<p>Background</p>  <p><small>http://en.wikipedia.org/wiki/Atmosphere_of_Earth</small></p>
<p><b>Muons</b> are the usual form of cosmic radiation that reaches the Earth</p> <p><small>http://en.wikipedia.org/wiki/Muon#Muon_decay</small></p>	

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

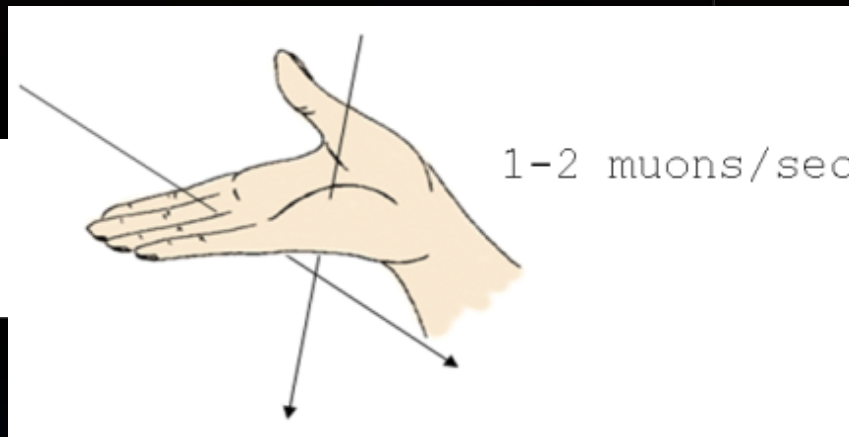
[http://en.wikipedia.org/wiki/Muon#Muon\\_decay](http://en.wikipedia.org/wiki/Muon#Muon_decay)

## 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>

The slide contains a diagram of a detector array. It shows a white rectangular area representing the atmosphere, with a grey horizontal line at the bottom representing the ground. Five small yellow squares are arranged in a row on the ground line, representing individual detectors in an array.

## Secondary Cosmic Radiation

# Detection

Background

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



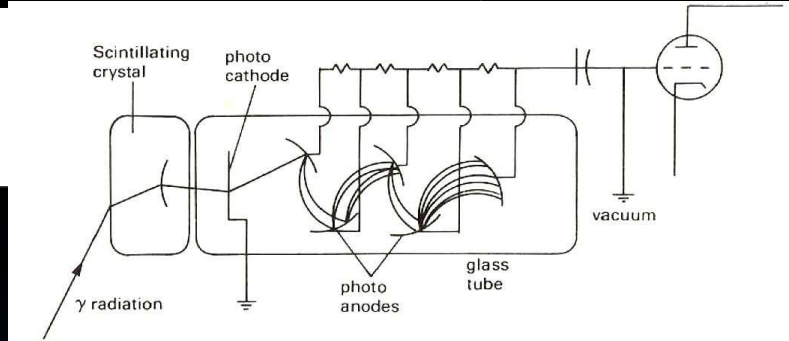
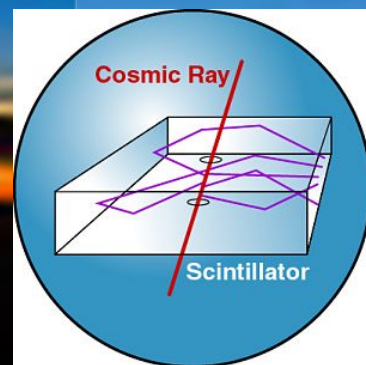
<http://cosmic.lbl.gov/documentation/CosmicDetector2-0.pdf>

## 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

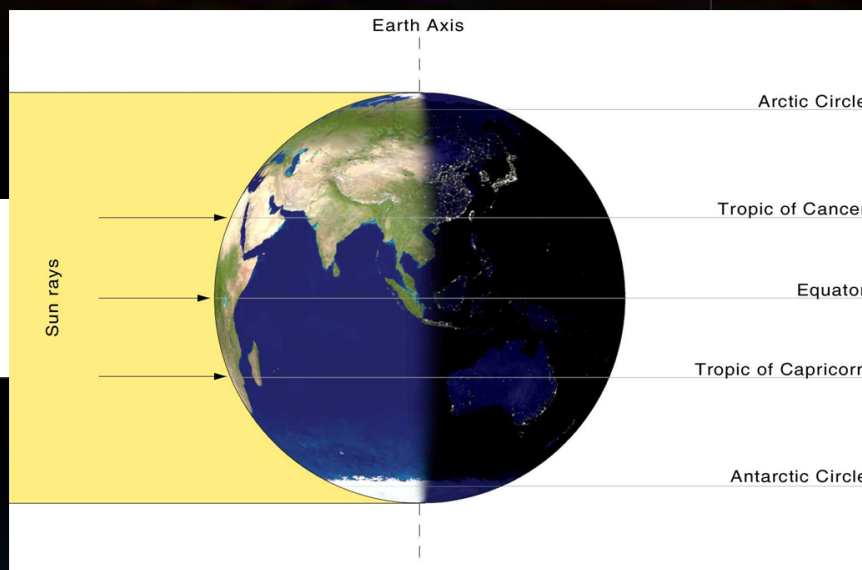


<http://durpdg.dur.ac.uk/vvc/cosmicrays/images/scintillator2.jpg>  
[http://2.bp.blogspot.com/-rvLZGzU7Bb8/TigHs4EvKI/AAAAAAAAAAW/s4I-Rx1y1\\_Y/s1600/scintillation+chamber.JPG](http://2.bp.blogspot.com/-rvLZGzU7Bb8/TigHs4EvKI/AAAAAAAAAAW/s4I-Rx1y1_Y/s1600/scintillation+chamber.JPG)

# 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/startswithabang/2010/03/21/weekend-diversion-a-little-sun/>

# Cosmic Maximus?

- 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.

The Test

...wikipedia.org  
...atmosphere\_0



View from the test site



The Scintillator Counter

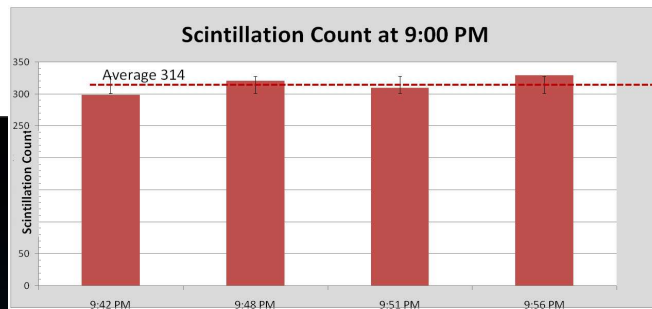
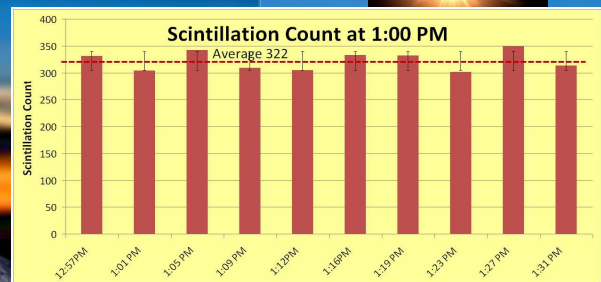
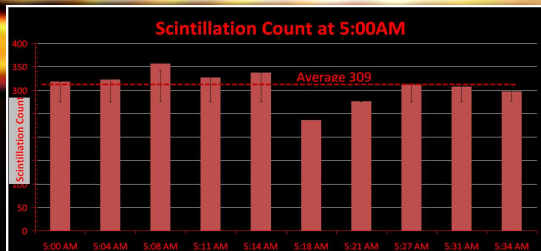


View of one of the scintillating panels wrapped in aluminum foil



# Cosmic Maximus?

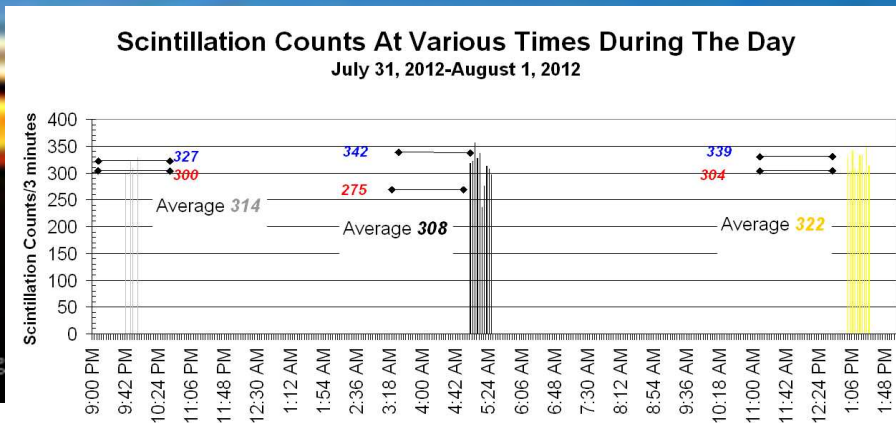
The Data



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

# Cosmic Maximus?

The Data

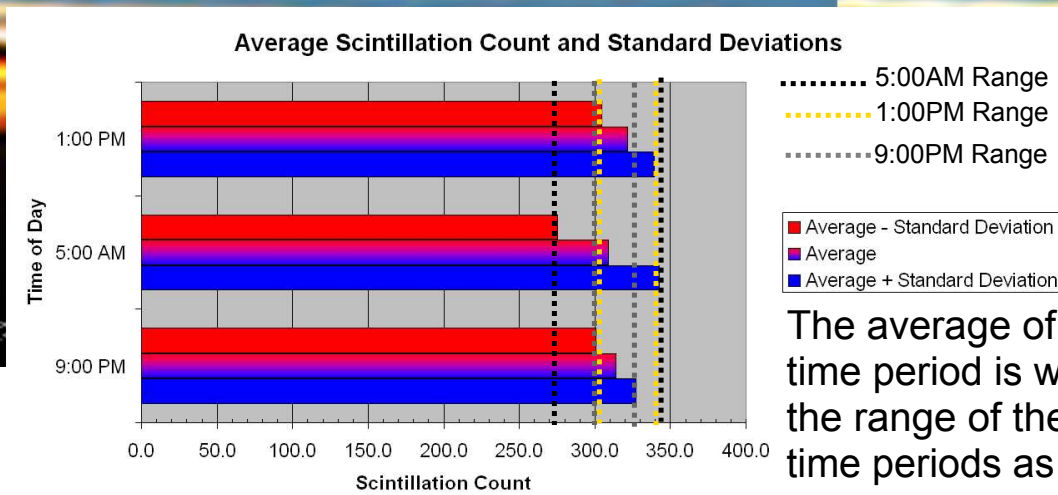


Notice that the averages all fit within the error ranges shown

[http://en.wikipedia.org/wiki/Atmosphere\\_of\\_Earth](http://en.wikipedia.org/wiki/Atmosphere_of_Earth)

# Cosmic Maximus?

Analysis



The average of each time period is within the range of the other time periods as well.

# Cosmic Consistnus?

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.



f\_Earth

<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.... :-)

