

# AMBIENTE DE RADIAÇÃO NO ESPAÇO

Patrícia Gonçalves

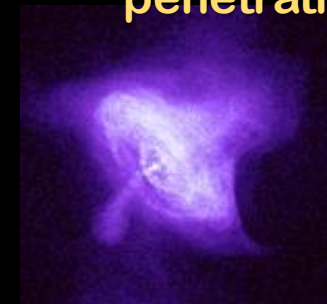
# Three sources of radiation

## Solar Events (SEP)

protons and electrons  
high flux  
low energy  
sporadic  
very dangerous

## Galactic Cosmic Rays

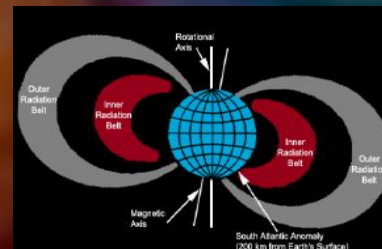
Protons and ions  
low flux  
very energetic  
penetrating



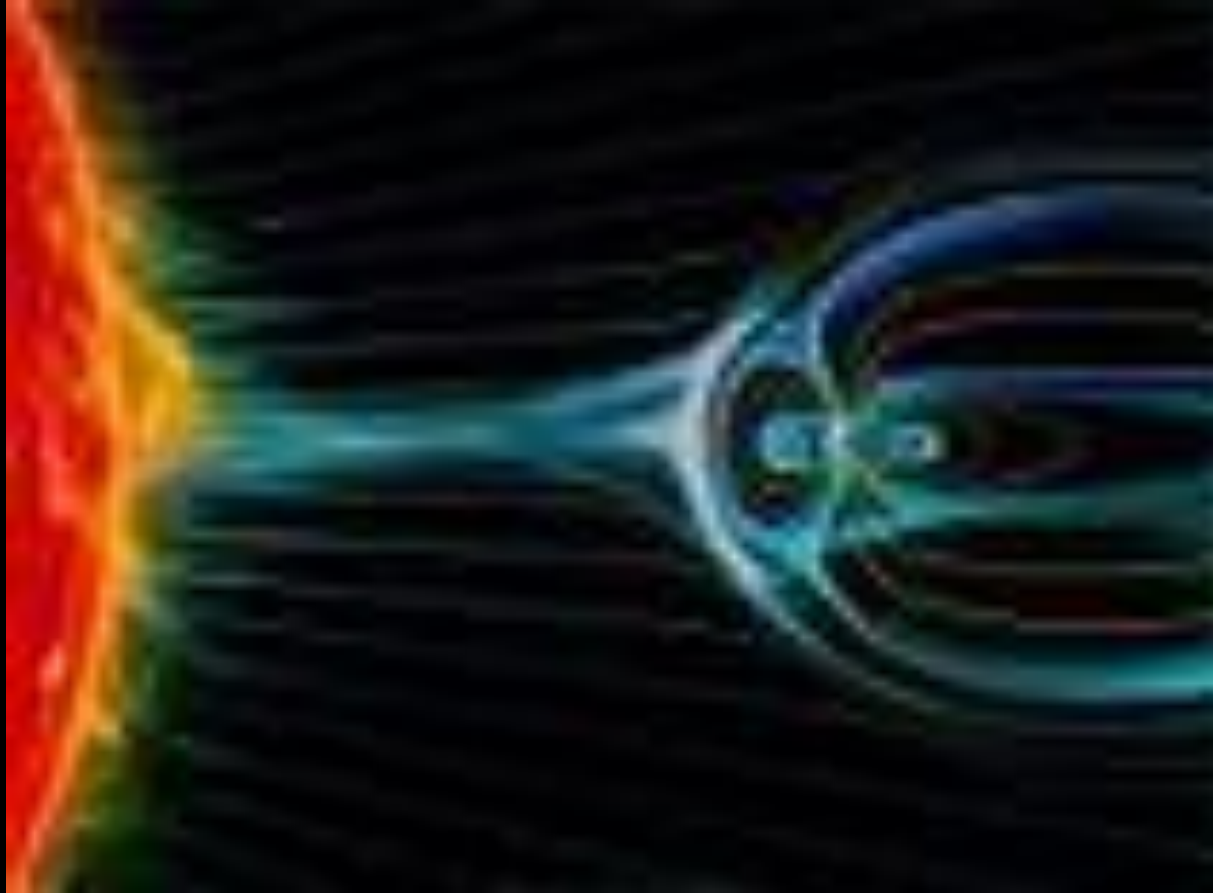
Supernova in Crab nebula  
seen in X-ray by the Chandra  
mission

## Planetary Radiation Belts

protons and electrons  
high radiation dose



# Magnetospheric Storms



See movie in: <http://www.youtube.com/watch?v=BDZj1CmsJ64&feature=related>



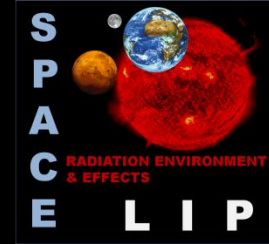
# Aurora



**Charged particles captured in the radiation belts excite N<sub>2</sub> and O<sub>2</sub> molecules that emit visible light while returning to the fundamental state.**

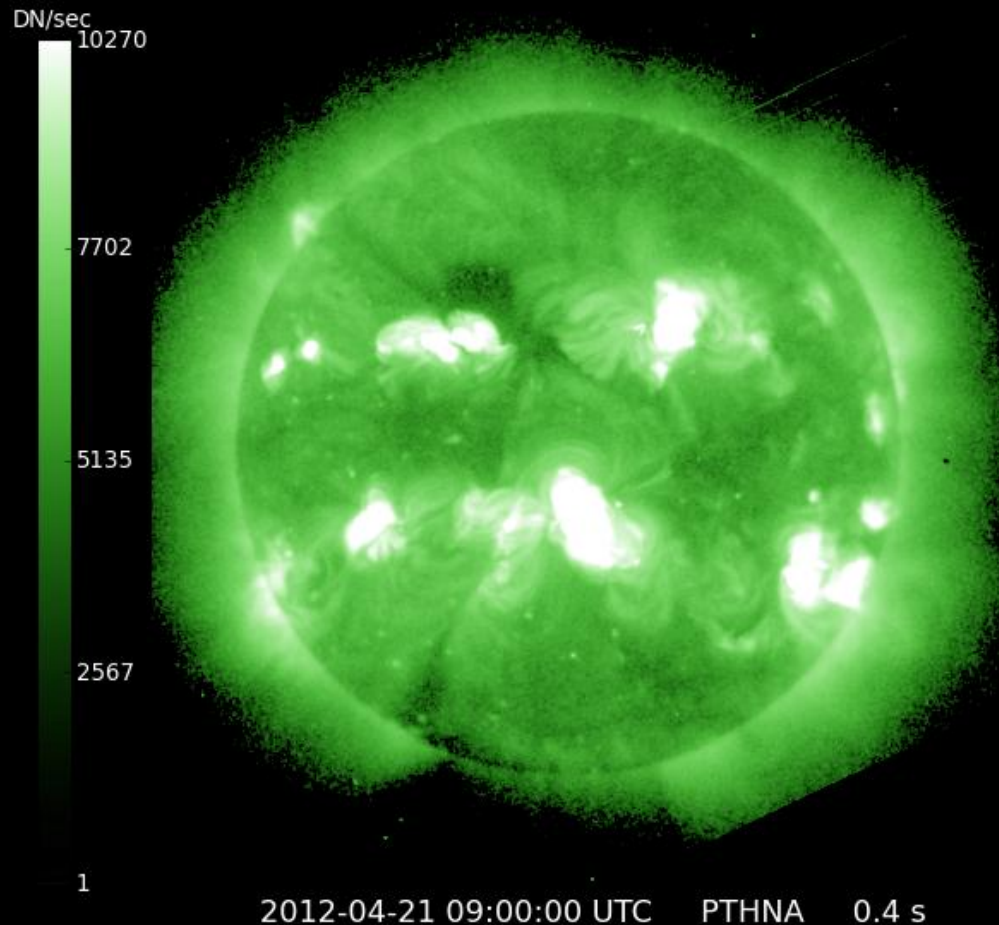


# Today's Space Weather



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

GOES-15 SXI Level-1  
NOAA/SWPC Boulder, CO



## 3-day Solar-Geophysical Forecast

**issued Apr 20 22:00 UTC**

### **Solar Activity Forecast:**

Solar activity is expected to be low through the period (21 - 23 April) with a chance for an isolated M-class flare.

### **Geophysical Activity Forecast:**

Geomagnetic field activity is expected to be at quiet levels during the first half of day 1 (21 April). Activity is forecast to increase to unsettled levels with a chance for active levels beginning around 21/1500Z and continuing into day 3 (23 April) due to expected glancing blows from the partial-halo CMEs observed on 18 and 19 April. There will also be a slight chance for minor storm levels on day 1.

# What we do

Model the radiation environment in space  
and  
study and measure the effects of radiation  
in EEE components and for human space flight

## An Example:

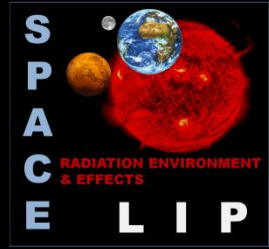
### **Radiation Environment Models**

**Model of the radiation environment on Mars,  
Phobos and Deimos, including local treatment of  
surface topography and composition,  
atmospheric composition & density  
(with diurnal + annual variations) and  
local magnetic fields.**





# Detailed Martian Radiation Environment Model developed by LIP



## Inputs

As a function of  $5^\circ \times 5^\circ$  in lat-long, season (12 SL intervals) & (day/night)

- Atmosphere composition: EMCD (European Mars Climate Database) or MarsGRAM (NASA)
- Topography from Mars Laser Altimeter aboard Mars Global Surveyor.
- Soil Composition from analysis of data collected with the Gamma Ray Spectrometer aboard Mars Odyssey, including water content and CO<sub>2</sub> ice.
- Magnetic Field Models, from PLANETOCOSMICS
- GCR spectra (  $\alpha$  solar cycle ): ISO 15390 model (Nymmik)
- SEP ( worst 5 minutes / total fluence): from models & data.

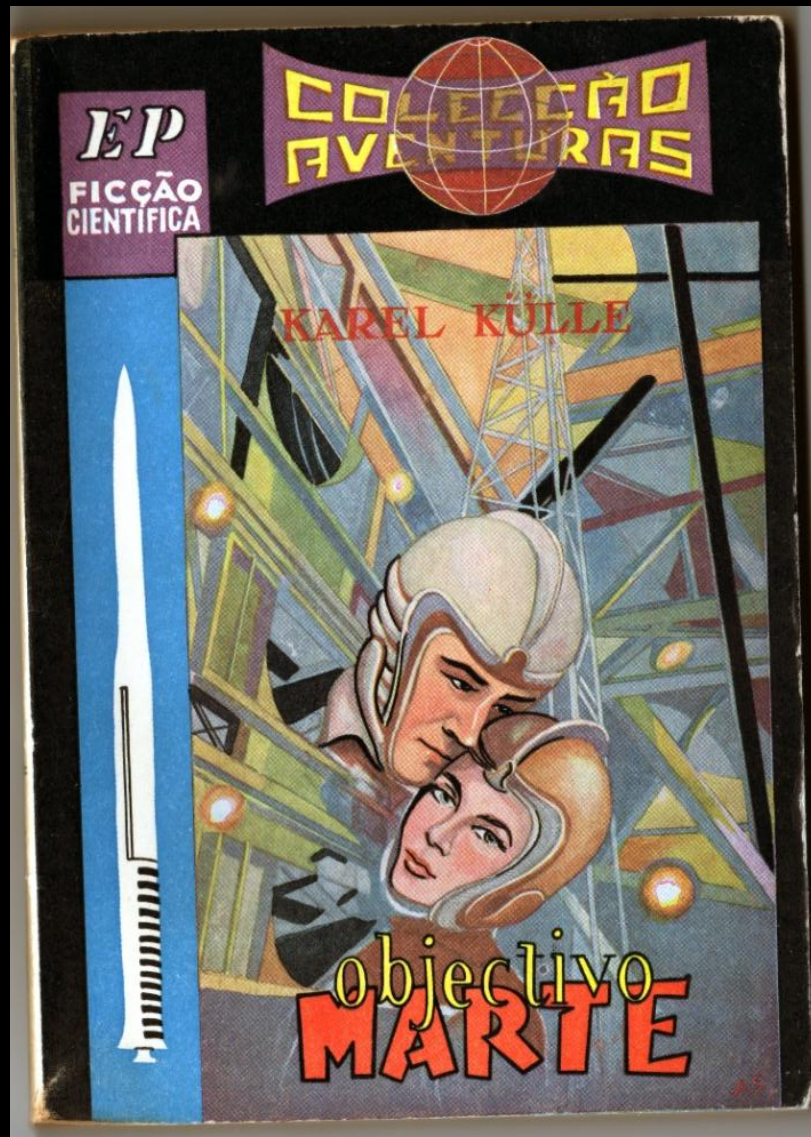
**...it is possible !**

**Predictions of the Models:  
It is possible to remain in Martian surface for some time  
with no serious risk for astronauts!**

**For longer permanences  
shelters are required...**



# The interplanetary travel



The most dangerous phase in a trip to Mars , from the point of view of the radiation hazard, is the interplanetary travel !

The biggest danger is the possibility of a SEP reaching the mission..

Mitigation Strategies are under development:

- Shelters inside water compartments or other
- Faster propulsion system
- SEP Forecasting tools and alarms

<http://www.lip.pt/~space>

## SPACE Radiation Environment & Effects

Study and simulation of the radiation environment in the heliosphere: radiation monitoring and effects on EEE components



### Master Degree theses subjects 2011/2012

- [Space Radiation Environment and Technology Demonstration In-flight Data analysis](#)
- [Radiation Environment and Habitability in the Jovian System: Exploring Europa, the Jovian Moon](#)
- [Radiation Environment and Effects in Human Space Flight: A Lunar Mission](#)

### [LIP Space Catalogue 2011](#)

#### Contact

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