

Search for gamma-ray emission from solar system bodies with *Fermi*-LAT

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Abstract. *Fermi* LAT is performing an all-sky gamma-ray survey from 30 MeV to >300 GeV with unprecedented sensitivity and angular resolution. *Fermi* has detected high-energy gamma rays from the Moon and Sun since the first weeks of data taking. This emission is produced by interactions of cosmic rays with these objects. Similarly, some gamma ray emission can be produced by interactions with asteroids and planets. We have searched this emission looking major planets during the first 6 months of data taking. We present here the status of the search.

Keywords: Gamma-ray astronomy, asteroids, cosmic-rays

I. INTRODUCTION

Fermi was successfully launched from Cape Canaveral on the 11th of June 2008. It is currently in an almost circular orbit around the Earth at an altitude of 565 km having an inclination of 25.6° and an orbital period of 96 minutes. After an initial period of engineering data taking and on-orbit calibration [1], the observatory was put into a sky-survey mode. The observatory has two instruments onboard, the Large Area Telescope (LAT)[2], a pair-conversion gamma-ray detector and tracker and a Gamma Ray Burst Monitor (GBM), dedicated to the detection of gamma-ray bursts. The instruments on *Fermi* provide coverage over the energy range measurements from few keV to several hundreds of GeV.

Here we report the results of a search for a gamma-ray diffuse component emissions due to major planets, jovian trojans, neptunian trojans, asteroids and debris of solar system. The cosmic-ray interactions with planets, asteroids, and objects in the Oort Cloud should produce a gamma-ray component due to the π_0 decays coming from the hadronic interactions by cosmic-rays hitting the surface of these bodies and any massive object of the solar system. Some recent works[3], [4] explore the possibility that this emission should be taken into account, when dealing about gamma-ray diffuse emission, and try to compute gamma-ray fluxes for a lot of interesting class of bodies, including comets. In particular the flux computations for the albedo gamma-ray emission from the Moon[5], [6] is taken as a template to extrapolate the emission from solid bodies, potentially able to emit albedo gamma-rays. Other observations[7] have reported visible and infrared observations and position calculations about the jovian trojan establishing the diameter

distribution and albedo measurements of these objects. Moreover in other works[8] these calculations are now including cosmic ray interactions with debris in the Oort Cloud and concluding that probably a fraction of the previously known as extragalactic γ -ray background could be due to these objects.

However while the emission from Moon[9] and Sun[9], [11], [10] was previously detected by EGRET, and confirmed by *Fermi* [12], [13], the gamma-ray flux from these interactions was never detected and should present an intensity level too low to be detected as pointlike sources. Therefore this emission should give a contribution to the extragalactic isotropic gamma-ray background. It is straightforward that in order to correctly evaluate the true extragalactic and galactic components of the diffuse emission, it's important to quote or to estimate upper limits of this local solar system component of gamma-ray emissions. The first 6 months of data sample are here used to look directly the most promising regions for this emission and the first preliminary results are here presented.

II. DATA SELECTION

The data sample used includes the scientific data collected since 4 August 2008 to the end of February 2009 (7months). We have applied a zenith cut of 105° to eliminate photons from the Earth's limb. We use for this analysis the "Diffuse" class [2], corresponding to the events with the highest probability candidates as photons. Science Tools version used is v9r11 and IRFs (Instrumental Response Functions) version P6_V3.

The best way to observe the γ -ray emission coming from the direction of major planets is to look the count maps in that regions. In most situations the planet displacement in the sky may be considered negligible and the standard *Fermi* Science Tools can be used. For any other case we apply the same tools developed for solar system bodies. We have then selected events in celestial coordinates relative to the position of major planets. Moreover we have tried the exploration of the ecliptic regions. For any selected object we have examined the count map to look for any evident excess of counts.

III. RESULTS

For this analysis we report only qualitative results about the γ -ray emission from large planets. Fig. 1 shows the count map of the events in celestial coordinates offsets relative to Jupiter position. We are starting to carefully quote the fluxes or the upper limits of the

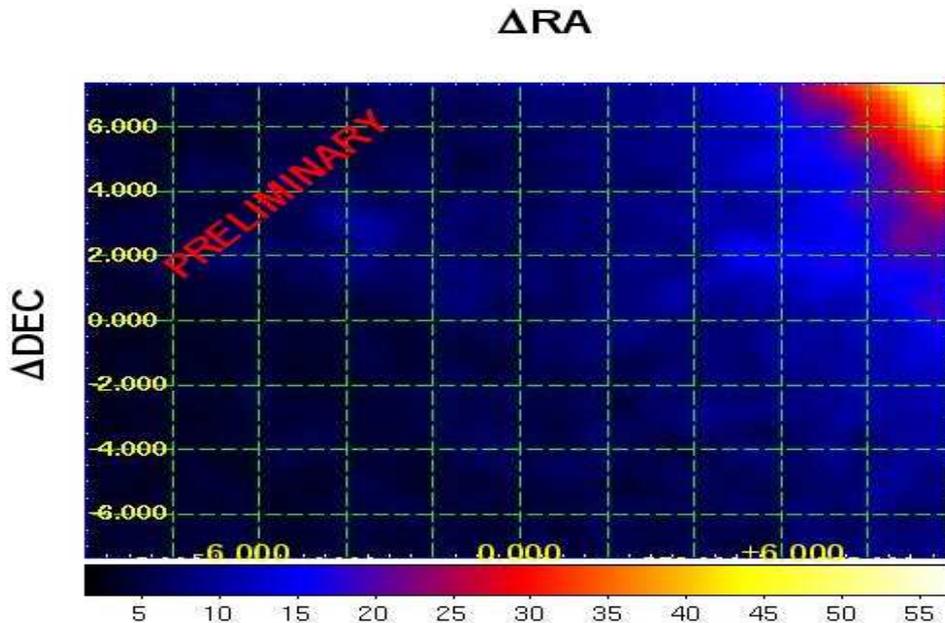


Fig. 1. Count map in the Jupiter region. Coordinates are celestial offset in degrees respect to the Jupiter position. The bin width used is 0.2° and the image is obtained using a colour scale linearly proportional to the counts; a gaussian smoothing using a kernel radius of 3, has then applied to the image. On the top right corner of the image is partially visible the galactic plane emission.

fluxes from these objects. However for this analysis, taking into account that the integrate sensitivity in the first 6 months should not be sufficient to have a clear evidence of emission from weakest sources and taking into account that Saturn and Jupiter has spent most of the time in regions close to the galactic plane, no clear emission centered on these planets is visible or within few degrees from these sources. We have moreover reviewed the regions close to Uran and Neptune too, and no signal was seen during the first six months.

IV. CONCLUSIONS

We have searched for the gamma-ray albedo emission from Jupiter. Using the first 6-months data we have no evidence of gamma-ray emission from this object. A detailed analysis search for emission from other bodies of the solar system objects, in particular from Saturn region, is in progress. However the sensitivity of *Fermi* to detect weak sources bring to conclude that increasing the statistics and the exposures, we should have the possibility to reveal at least the unresolved diffuse emission connected to these bodies.

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