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GLAST LAT and pulsars: what do we learn from simulations?

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Abstract. Gamma-ray pulsars are among the best targets for the Large Area Telescope (LAT) aboard the GLAST mission. The higher sensitivity, time and energy resolution of the LAT will provide data of fundamental importance to understand the physics of these fascinating objects. Powerful tools for studying the LAT capabilities for pulsar science are the simulation programs developed within the GLAST Collaboration. Thanks to these simulations it is possible to produce a detailed distribution of gamma-ray photons in energy and phase that can be folded through the LAT Instrument Response Functions (IRFs). Here we present some of the main interesting results from the simulations developed to study the discovery potential of the LAT. In particular we will focus on the capability of the LAT to discover new radio-loud gamma-ray pulsars, on the discrimination between Polar Cap and Outer Gap models, and on the LAT pulsar sensitivity.

Keywords: Gamma-rays, Gamma-ray telescopes, Pulsars
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INTRODUCTION

The Gamma-ray Large Area Space Telescope (GLAST) will have a dramatic impact on our knowledge of gamma-ray pulsars [1]. The main GLAST instrument, called Large Area Telescope (LAT) is a pair conversion telescope designed to detect gamma-rays from about 30 MeV up to about 300 GeV. The high sensitivity and effective area of the LAT will greatly increase the number of detected gamma-ray pulsars. Currently the predictions range from tens to hundreds of new gamma-ray pulsars according to the considered emission scenarios. The energy resolution and the energy range covered by the LAT will allow the study of the high-energy spectrum of pulsars, where a cutoff is expected. We developed some set of pulsar simulations using the tools developed within the LAT Collaboration and in particular the *PulsarSpectrum* simulator [2]. We used it for studying aspects of the LAT capabilities for pulsars, mainly regarding the number of pulsars and the ability to study high-energy cutoffs.

DETECTING RADIO-LOUD GAMMA-RAY PULSARS

In order to estimate how many pulsars the GLAST LAT will see, we used a simulated pulsar population generated for the LAT Data Challenge 2 (DC2), a simulation of 55-day LAT observation in scanning mode generated by the LAT Collaboration. For the DC2 a detailed skymodel was produced with several source classes, including variable sources such as blazars, GRBs and pulsars. The pulsars in DC2 have been simulated using the *PulsarSpectrum* simulator, developed within the LAT Collaboration [2]. Realistic pulsar populations have been produced mixing 4 groups of pulsars with different characteristics, including isolated pulsars [3] and millisecond pulsars [4]. We used an automatic analysis procedure written in Python language and using the LAT Science Analysis Tools that select the region around a pulsar and apply χ^2 periodicity test on that. The detection of the simulated pulsar is chosen when the chance probability P is less than 10^{-9}. A *Low-confidence* detection is established if the chance probability is within 10^{-9} and 2×10^{-3}. A distribution of flux is also obtained as shown in the Figure 1. The 78 projected number of pulsars detected with high confidence in 1 year agrees well with the number (81) of radio-loud pulsars detected by a 1 year LAT survey in the simulation of Gonthier et al. (see poster P14.32 at this Symposium) assuming Slot Gap cascade emission.

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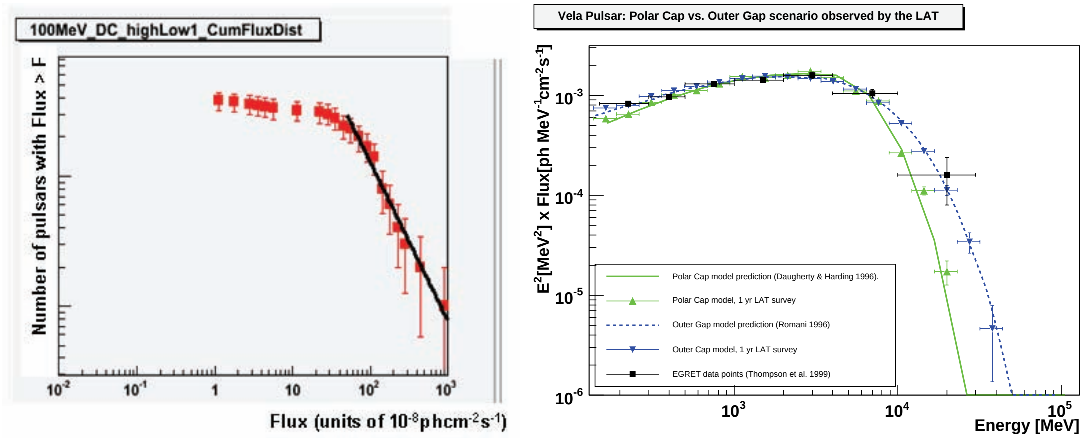

FIGURE 1. Left: Cumulative distribution of pulsar flux for the radio-loud pulsars detected in the simulated data of LAT DC2. The change of slope is clearly visible, showing the edge of the Galactic plane. Right: A simulation of the spectrum of Vela observed by the LAT showing the possibility to distinguish between Polar Cap [5] and Outer Gap [6] emission. The EGRET points are shown for comparison.

LAT DETECTING PULSAR HIGH-ENERGY CUTOFF

Polar Cap and Outer Gap models make different predictions about the high-energy cutoff of pulsars. Polar Cap models predict a sharp super-exponential cutoff due to pair production in high magnetic fiels. Outer Gap models predict an exponential cutoff due to radiation-reaction limited emission. We chose the Vela pulsar since it is the brightest in the sky and we simulated a 1-year LAT observation using a Polar Cap model [5] and an Outer Gap model [6]. We show that LAT will be able to distinguish between models at a level of 3σ on a time scale of a couple of weeks of continuous scanning mode.

A SENSITIVITY STUDY FOR PULSED EMISSION

Another interesting topic is to study the LAT sensitivity for pulsed emission. Since in this case the timing information is used we expect that this sensitivity limit is less than the sensitivity limit for steady point source detection. An automated analysis has been developed and the sources on the plane have been studied for now. As a preliminary result we have that near the plane in one month a flux limit of about 10^{-7}ph cm^{-2}s^{-1}can be achieved. All the studies presented in this contribution are currently still under development and refinement. Although the results are preliminary it appears that simulations are a powerful tool for investigating LAT capabilities in studying gamma-ray pulsars.

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