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The future look at the Galaxy with the Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO)

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In the past 15 years, observations of the Galaxy at high energies by Fermi-LAT, AGILE, INTEGRAL and very recently by NuSTAR and eROSITA have been shown to be very exciting, allowing discoveries of a variety of objects and unexpected breakthroughs. However, from a few hundreds of KeV to several tens of MeV, the Galaxy remains poorly explored. In this energy range the lack of sufficiently sensitive instruments limits potential discoveries and challenges our understanding of the Galactic high-energy processes and sources. To solve this issue, GECCO is a new mission concept that will allow high-sensitivity observations of the sky from ~50 KeV to ~10 MeV. It combines a coded aperture mask technique that provides high angular resolution for source detection, and a Compton telescope that provides high-sensitivity measurements of diffuse emissions. Such a combination enables efficient separation between sources and diffuse emissions. A GECCO-like mission has the potential of answering open questions and leading to new discoveries. Among the most recent challenges regarding the Galaxy, sensitive observations at MeV energies with unprecedented high resolution will open a new window in understanding complicated regions such as the inner Galaxy, the origin of the Fermi Bubbles, the origin of the 511 keV line, and it will provide new insights on element formation in dynamical environments, on possible Galactic winds, and on the mechanisms of propagation of the low-energetic cosmic rays, their sources and their role on the Galaxy evolution.

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1. Introduction

In the past 15 years, observations of the Galaxy in x-rays and gamma rays have allowed exciting discoveries of a variety of objects and also unexpected breakthroughs. However, from a few hundreds of keV to several tens of MeV, the Galaxy remains poorly explored due to the lack of sufficiently sensitive instruments in this energy range. Moreover, past instruments in the MeV energy range did not have enough angular resolution to disentangling sources from diffuse emission.

We present a new mission concept for a gamma-ray telescope in the MeV energy range, called GECCO.

2. The GECCO Concept

GECCO is a fully innovative mission concept in the energy band from 50 keV to 10 MeV [1]. It combines a coded mask telescope that provides high angular resolution for source detection, and a Compton telescope that provides high-sensitivity measurements of diffuse emissions and a larger field of view.

Such a combination enables efficient separation between sources and diffuse emissions, and among sources in crowded regions.

3. GECCO Objectives

The objectives for Galactic science are the following:

a) Allowing a deep look at the Galactic center with the aim of understanding the nature of the central super-massive black hole and the Fermi LAT Galactic Center excess (e.g. [2, 3]).
b) Detecting known and new sources thanks to the capability of disentangling and resolving sources and of distinguishing sources from the truly diffuse emission.
c) Investigating the origin of the gamma-ray Fermi Bubbles (e.g. [4]) and the x-ray Bubbles (e.g. [5]).
d) Tracing low-energetic cosmic rays, their propagation, their sources, and their role in the Galaxy evolution and star formation by detecting both continuum emission and de-excitation nuclear lines (e.g. [6] and references therein).
e) Allowing the study of the Galactic chemical evolution and the sites of nucleosynthesis of elements (e.g. [7]), and clarifying the origin of the 511 keV electron-positron annihilation line (e.g. [8]).

4. Conclusions

A GECCO-like mission has the capability of answering open questions that other missions and multifrequency observations do not have, and it has the potential of leading to new discoveries.

5. References

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