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RUNAWAY MASSIVE STARS AS A NEW CLASS OF GALACTIC GAMMA-RAY SOURCES

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Runaway stars have high spatial velocities,  $V > 30$  km s $^{-1}$ , and if they are massive, can produce bowshocks in the surrounding ISM. These bowshocks develop as arc-shaped structures pointing in the same direction as the supersonic stellar velocity. The piled-up shocked matter emits thermal radiation. Additionally, a population of locally accelerated relativistic particles can produce non-thermal emission over a wide range of energies. This has been recently confirmed by a bunch of observations at radio, X-ray and even gamma-ray wavelengths. Runaway early-type stars might be variable gamma-ray sources, with variability time scales depending on the scales of density inhomogeneities in the medium and the stellar velocity. Protons can easily escape from the emitting region without much loss of energy. These protons might diffuse in the surrounding molecular cloud interacting with the matter via p-p inelastic collisions. These yield gamma rays and secondary particles. Molecular clouds illuminated by these relativistic particles might become into diffuse non-thermal sources. We calculate all relevant non-thermal processes related to these stellar objects and discuss the observational prospects.

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THE GALACTIC DISTRIBUTION OF FERMI POINT SOURCES

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The second catalog of high-energy  $\gamma$ -ray sources detected by the Large Area Telescope (LAT), the primary science instrument on the *Fermi Gamma-ray Space Telescope*, allows us for the first time to perform a modeling of the galactic distribution of such sources based on the method of summing up all detectable sources in a grid of lines of sight. The challenge is to produce reliable estimates of counts

from small numbers. The catalog contains 1873 sources over the whole sky, giving an average of 0.036 counts/deg $^2$  for  $|b| > 60^\circ$ . In a narrow strip centered at  $|b| < 0.5^\circ$  we find 128 sources. In this work, we describe our attempts to estimate the density of  $\gamma$ -ray sources along both galactic longitude and galactic latitude. The results of the estimated source counts are compared with the predictions of a model which has an exponential distribution in the radial direction as well as an exponential distribution above the galactic plane. Our conclusions point to a radial length scale consistent with that obtained from near-infrared counts and a very short height scale, typical of very young populations in the Galaxy. We tested both Gaussian and Power-Law forms for the luminosity function. The luminosities cover the range  $10^{33} - 10^{36}$  erg/s in the 100 MeV–100 GeV band with space densities (in the solar neighborhood) of  $\sim 10^{-8}$  pc $^{-3}$ .

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A MAGNETIC RECONNECTION MODEL FOR EXPLAINING MICROQUASARS RADIATION

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Very high energy observations of AGNs and microquasars are challenging current theories of particle acceleration (mostly based on shock acceleration) which have to explain how particles are accelerated to energies above TeV in very compact regions compared to the characteristic scales of their sources. The identification of microquasars and AGNs as sites of particle acceleration raises many fascinating and important questions. Recent magnetohydrodynamical studies have revealed that cosmic ray acceleration by fast magnetic reconnection can be rather efficient because a first-order Fermi process may occur. In this work, we discuss this acceleration mechanism in the coronal region of the accretion disk around microquasars and AGNs. In addition, the accelerated particles lose substantial amounts of their energy due to non-thermal interactions with the surrounding magnetic field, matter and radiation fields. We compute the corresponding acceleration rate and the relevant loss rates in order to reproduce the observed spectral energy distribution for two microquasars (Cygnus-X1, Cygnus-

X3), considering the model above and leptonic and hadronic processes.

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## HIGHLIGHTS ON $\gamma$ CAS-LIKE STARS

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The number of Be stars with unusually hard-thermal and variable X-ray emission like that of  $\gamma$ -Cassiopeiae increased from one to ten in seven years. It is possible that they could be progenitors of magnetars or account for the missing number of Be/WD binaries observed, and this can be further tested through careful characterization of the parameter space in which the X-ray emission occurs. Here, we present a compendium of the optical and X-ray properties of a sample of this new class of X-ray emitters and some very recent results presented by our group. We discuss the current understanding and emphasize results that strengthen the interpretation of magnetic activities near the Be star as being the source of the X-ray emission.

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## PROPERTIES OF GALAXY GROUPS SELECTED FROM CHANDRA X-RAY OBSERVATIONS OF THE BOÖTES FIELD

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Galaxy groups are not simply scaled down versions of rich clusters (e.g. Mulchaey 2000, Voit 2005). Due to a group's shallow gravitational potential, feedback processes play an important role in the group's evolution. It is important to understand galaxy groups since, in hierarchical clustering, they are the building blocks of large scale structure. Thus, in addition to determining the characteristics of groups, it is important to determine the mass function over the range that includes poor clusters and groups.

We present the properties of the galaxy groups selected in the Chandra X-Boötes survey (Kenter et al. 2005). Group redshifts are measured from the AGES (Kochanek et al. 2012) spectroscopic data. We use photometric data from the NOAO Deep Wide Field Survey (NDWFS) (Jannuzi & Dey 1999) to estimate the group richness ( $N_{gals}$ ) and the optical luminosity ( $L_{opt}$ ). Our final sample comprises 32 systems at  $z < 0.80$ , with 14 below  $z = 0.35$ . For these systems we estimate velocity dispersions ( $\sigma_{gr}$ ) and perform a virial analysis to obtain the radius ( $R_{200}$  and  $R_{500}$ ) and mass ( $M_{200}$  and  $M_{500}$ ) for groups with at least five galaxy members. We use the Chandra X-ray observations to derive the X-ray luminosity ( $L_X$ ). We examine the performance of the group properties  $\sigma_{gr}$ ,  $L_{opt}$  and  $L_X$ , as proxies for the group mass. Understanding how these observables measure the total mass is important to estimate how well the cluster/group mass function is determined. By extending the mass function to the group regime, we predict the number of groups that new X-ray surveys, eROSITA, will detect.

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## COSMOLOGY

### GAUSSIAN ANALYSES ON PLANCK CMB MAPS

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Extremely precise cosmic background radiation (CMB) data from *Planck* satellite confirmed the cosmological model  $\Lambda$ CDM and established tight constraints for several features of the primary and secondary CMB temperature fluctuations. Possible non-Gaussian (NG) contributions to the CMB field could be originated during (or soon after) primordial cosmic inflation, where the types, scale dependences, and intensities expected depend on the inflationary models. For this, the robust detection –or not– of primordial NG in the CMB signify a unique probe to the early universe, allowing to distinguish between competing models. Recent analyses from *Planck* CMB data strongly limit the level of NG and show consistency with the Gaussian hypothesis although they do not exclude the presence of weak Gaussian deviations. A problem inherent with the confidence of a positive detection is the possibility that any non-primordial contamination could be