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Some possible observing programmes in stellar and galactic astronomy with the TAUVEX

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Abstract. While the major part of the survey observations with the TAUVEX will be targeted on high galactic latitudes and celestial poles there are many observing proposals for stellar and galactic astronomy. Some of these on young stars, energetic outflows, flare stars, hot dwarfs, planetary nebulae are briefly discussed. A preferred sky area for Galactic observations is also suggested.

Keywords : space astronomy: instruments, TAUVEX – stars: pre-main-sequence, flare, white dwarfs – ISM: jets and outflows, planetary nebulae – Galaxy: Galactic plane

1. Introduction

TAUVEX is an imaging instrument. It has a fairly large ($\sim 0.9°$) field of view and a modest spatial resolution ($\sim$6-10$''$). Constrained by the mechanics of GSAT-4, TAUVEX can only scan the sky in strips parallel to celestial latitudes at scan rates that depend on the latitude. The scan rate is the fastest (0.25°/minute resulting in an integration time of 216 sec for a point source in the field of view) at the celestial equator, decreasing towards the poles with $\cos\delta$, where δ is the celestial latitude. Thus the integration time per scan is larger at higher celestial latitudes. Deep-imaging observations with the TAUVEX are therefore more efficiently done in high celestial-latitude fields. For most extra-galactic observations this situation is favourable and TAUVEX will be profitably used for such work. Galactic UV astronomy can also be expected to make significant advances with TAUVEX observations.

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A great variety of objects and physical processes are known to make the Milky Way and shape its evolution. Objects and processes similar to those in the Milky Way (or more extreme versions of the same) often dominate the observed behaviour of most extra-galactic sources. The Galactic sources, of course, can be studied with much higher resolutions. In response to an announcement of opportunity regarding “science with TAUVEX” a number of preliminary observing proposals were received by the TAUVEX Team. Here we list and briefly describe those which propose to use TAUVEX observations of Galactic sources.

2. A strip of the sky for Milky Way studies with TAUVEX

Most of the sources of ultraviolet radiation and objects of interest for the study of the interstellar medium in the Milky Way like the massive hot stars, HII regions, young stars, nebulae etc reside in the Galactic disk. Therefore, they are to be found in a somewhat narrow band parallel to the Galactic equator. But the TAUVEX can only scan the sky in strips parallel to the celestial equator. Since the plane of the Galactic equator is inclined at an angle of 63° (more accurately $62°36'$) to the celestial equator, the largest overlap of the Milky Way disk and a TAUVEX observing strip with constant declination in the equatorial coordinates will be at: $\delta = +63°$ or $-63°$. TAUVEX scans of the sky near these declinations will have relatively large parts of the Galactic disk near Galactic latitudes $b = 0°$.

3. Galactic astronomy with TAUVEX

3.1 UV observations of Young Stellar (and substellar) Objects (YSOs) in star forming regions

Young stellar objects (e.g. pre-main-sequence T Tauri stars, Herbig Ae/Be stars) found in and around star forming regions emit excess ultraviolet radiation that arises due to (a) accretion of matter and/or (b) unusually high magnetospheric activity in the convective atmosphere of the star. Young substellar objects like the brown dwarfs and giant exoplanets in star forming regions are also expected to behave similarly. In addition to a general high level of UV emission, there are intense flare events which are expected to be more prominent in the UV. TAUVEX can be used to observe a number of galactic star forming regions that contain YSOs at different stages of pre-main-sequence evolution to study the processes involved in the formation of stars.

Young stars are also known to generally go through a phase during which they eject matter at relatively high velocity ($100 - 300$ km s^{-1}) in the form of narrow jet-like bipolar outflows. Some of these extend to large distances from the high density cloud cores in which they form and interact with the lower density intra-cloud or interstellar gas. The Giant HH flows are examples of such objects. While the HH objects are sources of intense line emission, one expects a rising ultraviolet continuum from the interaction surface between the high velocity outflow gas and the effectively stationary, ambient gas where the temperature could reach values as high as $10^5 - 10^6$ K. This process could in fact be a very significant source of galactic ultraviolet emission. TAUVEX can be used to image the Giant HH outflows (typically, $10 - 50$ arcmin in size) that are in relatively low extinction regions in the ultraviolet. For a typical HH object in nearby star forming regions, like Taurus at $\sim$ 140 pc, flux densities $\sim 10^{-6} - 10^{-5}$ erg cm^{-2} s^{-1} in the UV bands can be expected. This study will lead to a better understanding of the way young stars disrupt their parent clouds and provide a new diagnostic tool to study the environments of these objects.

3.2 Survey of hot evolved stars in galactic open clusters

The evolution of intermediate mass stars can be rapid enough for their remnants (central stars of planetary nebulae (CSPN), white dwarfs) to be found still associated with the star clusters in which they were born. The CSPN and young hot white dwarfs will be strong UV emitters. Deep imaging survey of open clusters with TAUVEX will reveal these objects. Their study will throw important light on the evolution of intermediate mass stars and planetary nebulae.

3.3 UV imaging of large planetary nebulae

PN have hot central stars with strong ultraviolet emission. The nebular gas is photo/ collisionally ionised. Highly ionised species have strong emission lines in the ultraviolet. If dust is present, then stellar UV can also be scattered by the dust. Radial intensity profiles can distinguish between photoionisation and collisional ionisation as the former will produce a centrally concentrated intensity distribution while the latter will lead to shell like distributions.

Imaging of PN may also lead to the detection of the central stars of planetary nebulae that are optically not yet identified.

3.4 Flare stars

Low mass dMe stars can give rise to strong flares in the ultraviolet with brightenings as large as $5 - 10$ magnitude. Many of of the brightest time-variable objects in the Galaxy Evolution Explorer (GALEX) ultraviolet variability (GUVV) catalogue (Welsh et al. 2005), which contains information on 84 time-variables and transient sources are nearby M-dwarf flare stars. Their flare events can be of durations as short as a few 100 seconds. For such events TAUVEX will be able to obtain flare light curves even in a single scan.

3.5 Novae

Novae are cataclysmic binaries (white dwarf + red dwarf) that give rise to outbursts due to runaway thermonuclear reactions in the accreted material on the white dwarf's surface. Recent CHANDRA results (Orio 2006) have shown that most novae are bright in X-rays a few months after the optical outburst. As the nova brightness in the optical declines and ejected matter expands and thins out exposing the central hot regions, one may expect to detect UV emission. UV light curves for galactic novae, with simultaneous ground based optical monitoring, should be obtained with TAUVEX.

The short list of possible observing programmes given here is only representative. Some of the programmes on Galactic sources will need deeper imaging (therefore multiple scans) with the TAUVEX at the celestial latitudes mentioned above. The high-declination survey with the TAUVEX and data from scans at other latitudes will also be very valuable for studying the UV properties of Galactic sources.

References

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