THE PLANK MISSION AND X-RAY SOURCES

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ABSTRACT

The Planck Cosmic Microwave Background mission, which is planned to be launched in 2007 will map th entire sky at frequencies 30-860 GHz, with a sensitivity depending on direction and frequency. Some X-ray sources as AGNs and X-ray binary systems may be detected as foreground galactic and extragalactic point sources. Due to many detectors in the focal plane and the scanning strategy, light curves for a few variable sources can be constructed for periods up to 20 days. The possibility to make co-ordinate microwave and X-ray observations may be of interest for the X-ray community.

Key words: ESA; Planck mission, X-ray sources.

1. INTRODUCTION

The ESA Planck mission (Villa, Mandolesi & Butler 2003) main purpose is to investigate the Cosmic Microwave Background (CMB) radiation. The launch date is at the moment set to Aug. 15, 2007, and it will be launched together with the Herschel (IR) 3.5 m space telescope. The Planck observatory will carry a 1.5 m telescope which will focus radiation from the sky unto two arrays of detectors: one set of 22 extremely sensitive low frequency radiometers (LFI), covering frequencies from 30 to 70 GHz, and one set of 48 bolometers (HFI) covering frequencies from 100 to 860 GHz. The entire sky will be mapped twice. To get a clear view of the CMB radiation, foreground sources have to be identified and removed.Many thousands galactic and extragalactic sources will be detected this way. Some of these will also be X-ray sources.

1.1. Scan pattern and detection of variability

The Planck observatory will move in a Lissajou orbit around L2. The orbital velocity will be about 2.5 archmin per hour, and the satellite spin rate will be about one revolution per minute. However, due to the distribution of detectors in the focal plane, a point source will be ”seen” by the various detectors at different times, and observed many times. The actual numbers of observations will depend on the final scan pattern and the ecliptic latitude of the source. For instance a point source at 70° ecliptic latitude will be observable for about 20 days, and detected in 30 scans within the FWHM of the 30 GHz detectors main beams (Terenzi et al 2002). In other words, we may get a light curve with 30 points spread over 20 days at this frequency if the source each time is detected. At lower ecliptic latitude the coverage will be shorter - down to 7 days near the ecliptic plane. Simulations show that the precision in the flux reconstruction depends on the average flux of the source, the ecliptic latitude and the frequency. (Terenzi et a.l 2002). Due to the many frequencies covered, the spectral index and spectral index variations will also be determined.

A Quick Detection System (QDS) will be used as a tool for detection of variable point sources which may be of interest for rapid follow up at other wavelengths. QDS is designed primarly as a tool for detection of outburst of active galaxies, but may also detect outburst of a few interacting binary systems - many of those being X-ray transients. Since data will be transmitted from the Planck observatory to the ground station only once per day, and the first processing takes some time, it means that ”quick” in this context is a few days.

The scan pattern will be repeated after one half year, so it will also be possible to detect variability on that time scale. An Early Release Compact Source Catalogue is planned to be released 22 months after launch of the Planck obserevatory.

1.2. The full mission sensitivity

After the mission is completed a the final point source catalogue will be prepared. The plan is to published it 42 months after launch. Table 1 gives the expected full mission point sources detection limits (3σ) and the beam width for the different detectors.

Table 1. Estimated full mission detection limits (3σ) for point sources

Frequency $[Ghz]$	Wavelength $[mm]$	Detection limit $[mJy]$	Beam size [arcmin]
30	10	39	30
44	6.8	57	23
70	4.2	75	14
100	3.0	27	9.2
143	2.1	33	7.1
217	1.4	33	5.0
353	0.85	57	5.0
545	0.55	114	5.0
857	0.35	129	5.0

2. EXTRAGALACTIC POINT SOURCES

The Planck observatory will make the first all sky survey at mm and sub-mm wavelengths that is sensitive enough to detect thousands of extragalactic sources. The LFI instrument will see mosty very extreme sources like blazars and very young and compact radio sources as the Gigaherz Peaked Spectrum (GPS) sources, or Compact Symmetric Objects (CSO).The fact that it will provide us with a full-sky, unbiased survey will tell us whether we have missed significant numbers of such extreme sources because they appear insignificant in the long wavelength surveys. We may also expect to obseve radio afterglows of some gamma ray bursts.

The HFI instrument will see the brightest and the coolest IRAS type galaxies. Most of them should be already be cataloged objects but again the survey will be unbiased, and may find some very low temperature objects. The large population of dusty galaxies span a wide range from low redshift star forming galaxies to active sources (starburst and AGNs) at high redshift.

Finally, and perhaps most crucially, Planck will find thousands of clusters of galaies by their Sunyaev-Zel'dovich (SZ) signal, a direct measure of the electron pressure in the cluster. These should both supplement X-ray selected clusters and provide many interesting targets for future X-ray observations. The important point is that the Planck SZ survey will be unbiased, and have very different selection criteria than X-ray surveys.

3. GALACTIC POINT SOURCES

The galactic point sources detected by Planck may either be related to star birth or to the late stages of stellar evolution. Related to star birh we will find HII rgions an star foming complexes – more than 1400 sources with eiher a cold dust (50K) or hot (10 000K) free-free radiation are expected to be detected at the Planck frequencies. In addition we nay find a large number of cold (15K) cores of molecular clouds.

Among the late stellar stages we may observe post-AGB stars with expanding dusty shells, and planetary nebulae with dusty envelopes. The many frequencies may make it possible to detect multiple cold dust shells related to previous episodes of mass ejection.

3.1. Interacting binaries and transient X-ray souces

We expect only a few interacting binary systems to be detected by the Planck instruments. The prime candidates are X-ray binaries, of which 20% show radio syncrotron emission. Most of these objects have episodic obutburst, and more than 25 may be above the detection limit at some time during the Planck mission. Only a few objects are in a persistant high state and of these only SS 433 and GRS 1915+105 are bright enough to be detected. We also expect to detect some symbiotic stars, in particular those with dust shells (D-type), which will show up at the higher frequencies.

4. CONCLUSION

The Planck all sky suvey is an unique possibility to obtain an unbiased survey of galactic and extragalactic microwave point souces. The QDS gives the opportunity to organise follow up observations at other wavelengths of variable sources shortly aftter the Planck detection. Knowing the scan pattern on beforehand makes it possible to do simultaneous observatons at other frequencies of known objects that Planck may detect, included many X-ray sources which also have radio and microwave components in their spectra. Approximate scan pattern will be known at the start of each of the two full sky surveys, and the final scan pattern will be known two weeks before it is executed. This should give opportunities to prepare simultaneous observations at other frequencies.

REFERENCES

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