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CAMISTIC: THz/submm astronomy at Dome C in Antarctica

Vincent Minier, Gilles Durand, Pierre-Olivier Lagage and M. Talvard

Service d'Astrophysique/DAPNIA/DSM/CEA Saclay, F-91191 Gif-sur-Yvette, France
email: vincent.minier@cea.fr

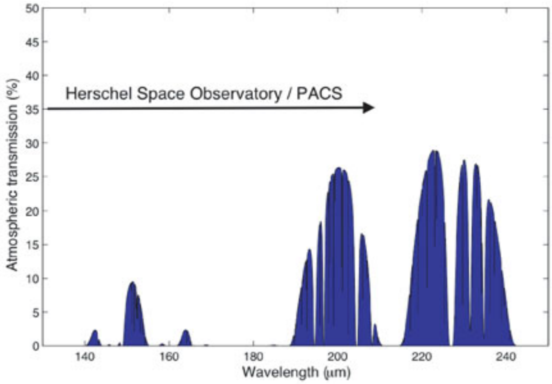
1. Project context

Submillimetre (submm) astronomy is the prime technique to unveil the birth and early evolution of a broad range of astrophysical objects. It is a relatively new branch of observational astrophysics which focuses on studies of the cold Universe, i.e., objects radiating a significant – if not dominant – fraction of their energy at wavelengths ranging from $\sim 100\,\mu$m to ~ 1 mm. Submm continuum observations are particularly powerful to measure the luminosities, temperatures and masses of cold dust emitting objects. Examples of such objects include star-forming clouds in our Galaxy, prestellar cores and deeply embedded protostars, protoplanetary disks around young stars, as well as nearby starburst galaxies and dust-enshrouded high-redshift galaxies in the early Universe.

A major obstacle to carry out submm observations from ground is the atmosphere. Astronomical observations in the submm spectral bands can only be achieved from extremely cold, dry and stable sites (e.g., high altitude plateau, Antarctica) or from space (e.g., the *Herschel Space Observatory*) to overcome the atmosphere opacity and instability that are mainly due to water vapour absorption and fluctuation in the low atmosphere. Chile currently offers the best accessible (all-year long) sites on Earth, where the precipitable water vapour (PWV) content is often less than 1 mm. Chile hosts the best astronomical facilities such as ESO VLT, APEX and Chajnantor plateau will be the ALMA site.

At longer term, and particularly if global warming severely restricts the 200 – 350 – 450 μm windows on ESO sites, Antarctica conditions with less than 0.2 mm PWV, could offer an exciting alternative for THz/submm astronomy (Fig. 1). This is an attractive opportunity for the 200 μm windows, especially, which are normally explored with space telescopes (e.g., *Herschel*).

Observations of submm continuum emission are usually carried out with bolometer detectors. Recently, two Research Departments at CEA (DSM/DAPNIA/SAp and DRT/LETI/LIR) developped filled bolometer arrays for the PACS submm/far-infrared imager on the *Herschel Space Observatory*, to be launched by ESA in 2007. The R&D was based on a unique and innovating technology that combines all silicon technology (resistive thermometers, absorbing grids, multiplexing) and monolithic fabrication. The bolometers are assembled on a mosaic 'CCD-like' array that provides full sampling of the focal plane with $\sim$2,000 pixels that are arranged in units of 256 pixels. They are cooled down to 300 mK to optimise the sensitivity down to the physical limit imposed by the photon background noise. The PACS bolometer arrays have passed all the qualification tests (Billot *et al.* 2006). The newly started ArTéMiS project at CEA Saclay capitalises on this achievement by developing submm (200 – 450 μm) bolometer arrays with $\sim$4,000 pixels for ground-based telescopes. A prototype camera operating in the 450 μm



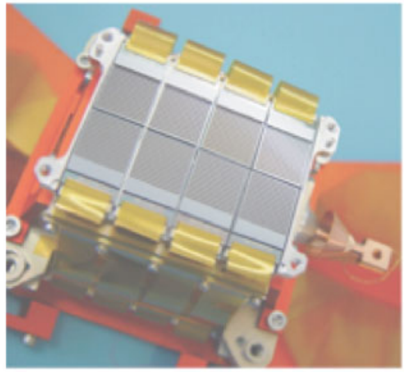


Figure 1. *Left*: Atmospheric transmission between 130 and 250 μm assuming a PWV = 0.2 mm. *Right*: CEA bolometer array for *Herschel Space Observatory*-PACS.

atmospheric window has successfully been tested in March 2006 on the KOSMA telescope (Talvard *et al.* 2006).

In the future, placed on a 12-m single-dish telescope at Dome C, a bolometer camera with $\sim$10,000 pixels at 200 – 450 μm will be particularly powerful to undertake wide field surveys of star-forming complexes in our Galaxy as well as deep field surveys of dust-enshrouded high-redshift galaxies in the early Universe.

2. CAMISTIC objective

The CAMISTIC project aims to install a filled bolometer-array camera with 16×16 pixels on a small telescope (e.g., IRAIT) at Dom C and explore the 200 μm (i.e., THz) windows for ground-based observations. Many windows between 150 and 250 μm are reachable if PWV is below 0.2 mm (Fig. 1), which is an expected value at Dome C (cf. Vernin, this SpS 7). Opening these windows would be an important achievement as this part of the electromagnetic spectrum is usually observed by the mean of space telescopes. Ground-based submm telescopes will have the advantages to be potentially larger than space telescope and, therefore, allow observations with higher angular resolution.

CAMISTIC will be located at about 500 m from the base, with very reduced access. Autonomous and automated cryogenic devices specifically designed for the harsh conditions in Antarctica will therefore be needed. We plan to demonstrate the reliability of a novel cryogenic system with all static parts placed next to cryostat at outer temperature conditions and a warmed cabinet for compressors, motors and valves. Extensive tests in wintering condition will be performed before expedition.

CAMISTIC will be equipped with novel bolometer technology. The filled bolometer array with a monolithic grid of 256 pixels was designed by CEA for the far-IR/submm imager *Herschel Space Observatory*-PACS. It can operate in the 150 – 250 μm range with an adequate filter for each specific window.

References

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