BLAST-Pol

www.blastexperiment.info

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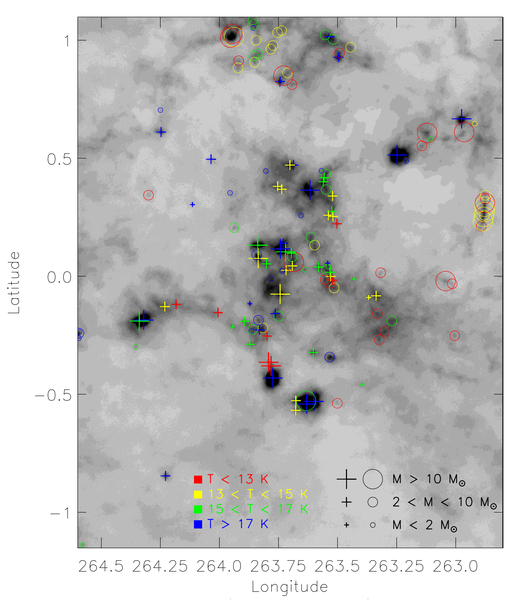
BLAST-Pol: *The Balloon-borne Large-Aperture Submillimetre Telescope for Polarimetry*

BLAST-Pol was created by adding polarimetric capability to BLAST, which flew in 2005 (from Sweden) and 2006 (from Antarctica).

BLAST was extremely sensitive to submillimeter emission on arcminute to degree scales, and has already produced 25 papers with several more in preparation.

BLAST-Pol's first flight has just ended and is expected to produce degree-scale submillimetre polarimetry maps of unprecedented sensitivity.



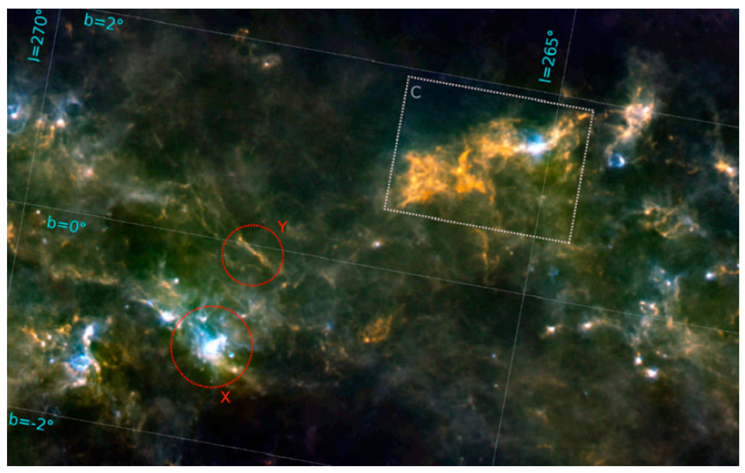
BLAST 2006 250μm map of Vela-D with cores colour-coded by temperature. Open circles show star-less cores and pluses are proto-stellar cores. Symbol size indicates source mass estimates. From Olmi et al., arXiv:0910.1097.

From BLAST to BLAST-Pol

- The BLAST experiment consists of:
  - 266 ^{3}He-cooled bolometers (SPIRE/Herschel prototypes)
  - 3 simultaneous bands: 250, 350 and 500μm
  - 1.9-m primary yielding 30–60″ resolution
- BLAST results:
  - Maps look just like simulations!
  - Data available at CADC and IPAC
  - BLAST the Movie, Nature, Physics Today, Colbert Report
- Science highlights:
  - First robust galaxy dN/dS at these wavelengths
  - Statistical resolution of CIB in deep fields
  - dN/dM estimates in star-forming regions
  - Discovery of cold (<14K) cores
  - Mapped diffuse Galactic emission at different latitudes
- BLAST telescope was rebuilt after destruction in 2006
  - with added polarization capability

Why BLAST-Pol?

- One of the key goals of astrophysics is to learn how stars form and how their masses are determined?
- Which processes regulate the overall rate at which stars are born? Observations of dust emission and extinction show that the dN/dM cloud-cores is strikingly similar to the the IMF. So does the origin of the IMF lie in the power spectrum of density fluctuations in turbulent molecular clouds? Although modern numerical simulations are able to reproduce some key features observed in these clouds, more detailed observations are needed.
- Despite recent advances, fundamental questions regarding molecular cloud structure are still being debated. Are they dynamical structures, as well as the cores, clumps, and filaments within them? Are the lifetimes of these structures approximately equal to their turbulent crossing times?
- A related issue is the role of large-scale magnetic fields in molecular clouds. If clouds and cloud sub-structures do indeed live longer than a crossing time, they may require the support against gravity provided by magnetic fields. However, the morphology and the characteristic strength of magnetic fields in molecular clouds are generally not well constrained by observations.
- BLAST-Pol's submm polarization observations can answer these questions by tracking magnetic fields from ISM scales to star-formation scales.



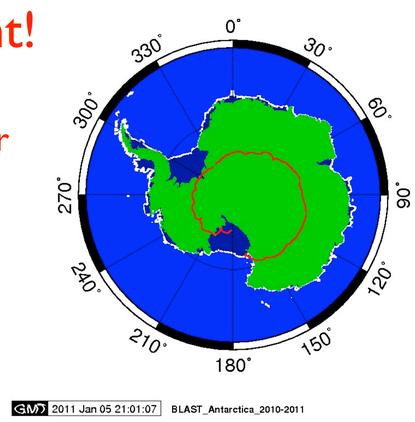
BLAST 2006 map of the Vela region (Netterfield et al., arXiv:0904.12072) with blue, green and orange showing the 3 submm colours. The cool, massive molecular cloud in box C is a prime BLAST-pol target; such targets will allow us to study the initial conditions of star formation in clouds. X shows a region which has already been heated by young stars, while Y is a filamentary structure.

Experimental Design

- ^{3}He fridge backed by ^{4}He-pumped pot provides 3 days of continuous operation after one 1.5 hour cycle.
- Hold-time of main He/N tanks > 11 days
- Offner-relay design with Lyot stop
- Secondary mirror adjustable during flight to 100μm
- Pointing reconstruction to 2″ accuracy
- Alternating-axis photolithographic polarization grids in front of detector arrays
- Polarization modulation provided by achromatic half-wave plate (AHWP)
- 5-layer sapphire AHWP coated using metal-mesh artificial dielectric
- AHWP is operated at 4K and is stepped by 22.5° several times each hour
- Achieves good modulation efficiency over 3 BLAST-pol bands spanning more than 1 octave
- Polarization efficiency is ~80%
- Instrumental polarization is less than ~1%
- New asymmetric Sun shields allow observations of Lupus and other 4th quadrant sources

Successful Flight!

- Launch 27 December
- Landing 5 January
- 9.5 days



TARGETS

- BLAST targetted several Southern fields
- Approximate list of observations:

Name	Area (deg^2)	Integration
Lupus I	~0.69	~55 hours
Lupus IV	~0.17	~15 hours
Vela Mol. Ridge (Axehead)	~1.4	~50 hours
Vela Mol. Ridge (Spearhead)	~0.14	~5 hours
Carina Nebula	~0.2	~3 hours
GMCs in Carina	~1.0	~13 hours
IRDC G321.934-0.052	~0.5	~5 hours
Cen A	~0.07	~2.5 hours
SPARO calibrators	~0.2	~5 hours
NANTEN Selected Region	~0.32	~23 hours

Photo: S. Benton