BaR-SPOrt: Balloon-borne Radiometers for Sky Polarization Observations

C. Sbarra\(^1\), S. Cortiglioni\(^1\), G. Bernardi\(^1\), E. Carretti\(^1\), S. Cecchini\(^1\), C. Macculli\(^1\), G. Ventura\(^1\), M. Baralis\(^2\), O. Peverini\(^2\), R. Tascone\(^2\), G. Boella\(^3\), S. Bonometto\(^2\), M. Gervasi\(^3\), G. Sironi\(^3\), M. Tucci\(^3,12\), M. Zannoni\(^3\), V. Natale\(^4\), R. Nesti\(^4\), R. Fabbrè\(^5\), J. Monari\(^6\), S. Poppi\(^6\), L. Nicastro\(^7\), R. Di Raffaele\(^7\), A. Boscaleri\(^8\), E. Pascale\(^8\), P. de Bernardis\(^9\), M. De Petris\(^9\), S. Masi\(^9\), M.V. Sazhin\(^10\), and E.N. Vinyajkin\(^11\)

1 IASF-CNR, Sez. di Bologna, Via Gobetti 101, 40129 Bologna, Italy
2 IRITI-CNR, C.so Duca degli Abruzzi 24, 10129 Torino, Italy
3 Dip. di Fisica Università di Milano Bicocca, Piazza della Scienza 3, 20126 Milano, Italy
4 IRA-CNR, Sez. di Firenze, largo E. Fermi 5, 50125 Firenze, Italy
5 Dip. di Fisica Università di Firenze, via Sansone 1, 50019 Sesto Fiorentino, Firenze, Italy
6 IRA-CNR, Sez. di Bologna, Via Gobetti 101, 40129 Bologna, Italy
7 IASF-CNR, Sez. di Palermo, via U. La Malfa 153, 90146 Palermo, Italy
8 IROE-CNR, via Panciatichi 64, 50177 Firenze, Italy
9 Dip. di Fisica Università La Sapienza, P.le A. Moro 2, 00185 Roma, Italy
10 Schternberg Astronomical Institute, Moscow State University, Moscow 119899, Russia
11 NIFR, 25 B. Pecherskaya st, Nizhniy Novgorod, 603600/GSP-51, Russia
12 Instituto de Física de Cantabria, Fac. de Ciencias, Avda. Los Castros s/n, 39005 Santander, Spain

Abstract. BaR-SPOrt, funded by ASI (Italian Space Agency), is a 32 (90) GHz balloon-borne correlation polarimeter for direct measurements of the Q and U Stokes parameters, with an angular resolution of 0.6° (0.2°). Aim of the experiment is the detection of the polarized emission of the diffuse Galactic Background and the Cosmic Microwave Background (CMB). The most likely launch site is Antarctica (2 to 4-week flight). Kiruna (Sweden, 1-week flight) and Svalbard (Norway, > 1-week flight) are possible launch site to observe the Northern sky.

1 The Science

Main scientific goal of BaR-SPOrt is measuring the linear polarization level of the sky emission on small sky patches [1]. Good observing targets, characterised by low emission from dust and synchrotron, exist in both the Southern and the Northern hemisphere (the area already observed by BOOMERanG [2] and, e.g., the area centered at RA=11h, DEC=45°, respectively). The expected polarization level \( P_{rms} = \sqrt{<Q^2> + <U^2>} \) of the CMB is maximum at small angular scales and is only weakly dependent on the cosmological model. If flown for 2 weeks or more, the instrument at 90 GHz, having a
beam of 0.2°, is expected to detect CMB polarization irrespective of the presence of a reionization period. The instrument at 32 GHz, with a beam of 0.6°, will at least be able to improve current upper limits on both CMBP and synchrotron polarized emission.

2 The Instrument

The polarimeter design has been developed to minimize instrumental effects and to increase long-term stability [4], as to reduce 1/f noise effects. The instrument shares most of the SPOrt [3] know-how. The main instrumental characteristics are:

- Low cross-polarization (< -40 dB) on-axis optics providing HPBW ≈ 0.6° at 32 GHz and HPBW ≈ 0.2° at 90 GHz;
- Correlation Unit based on custom design waveguide Hybrid Phase Discriminator, with unpolarized component rejection > 30 dB [5];
- Custom design OMT with high isolation (> 60 dB) to limit contamination from the unpolarized component;
- Custom design internal calibrator for polarized signals [6];
- A Cryostat to cool (< 80 K) LNAs, circulators, polarizer and OMT by a closed-loop cryocooler, and a thermal shield, temperature regulated, located inside the cryostat to increase the thermal stability.

<table>
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<th>Table 1. BaR-SPOrt technical characteristics</th>
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<tbody>
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<td>Frequency</td>
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<td>32 GHz</td>
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<td>90 GHz</td>
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References

5. O.A. Peverini et al., in Astrophysical Polarized Backgrounds, Bologna, Italy, October 9-12, 2001, ed. by S. Cecchini et al. (AIP Conf. Proc Vol. 609) pp. 177-182