CMB science: opportunities for a cryogenic filter-bank spectrometer

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CMB spectral science is experiencing a renewed interest after the impressive result of COBE-FIRAS in the early Nineties. In 2011, the PIXIE proposal contributed in a decisive way to reopen the prospect of measuring deviations from a perfect 2.725 K planckian spectrum. Both COBE-FIRAS and PIXIE are differential FTS spectrometers capable to operate in the null condition across ~2 frequency decades (in the case of PIXIE, the frequency span is 30 GHz- 6 THz). With this contribution we argue about a complementary strategy to observe CMB spectral distortions at frequencies lower than 250 GHz, down to the Rayleigh-Jeans tail of the spectrum. Our argument is that the throughput advantage, that makes the FTS capable of achieving exquisite sensitivity thanks to multimode operation, becomes the more and more limited going to lower frequencies. We demonstrate that an array of 100 cryogenic planar filter-bank spectrometers coupled to single mode antennas, on a purely statistical ground, can perform better than an FTS between tens of GHz and 200 GHz (a relevant frequency window for Cosmology) in the hypothesis that: (1) both instruments have the same frequency resolution; (2) both instruments are operated at the photon noise limit (with the FTS frequency band extending from ~tens of GHz up to 1 THz). We discuss here possible limitations of these hypothesis, and the constraints that have to be fulfilled (in terms of efficiency, detector inter-calibration, spectral cross-talk) in order to operate a cryogenic filter bank spectrometer close to its ultimate sensitivity limit.