SYMPOSIUM ON TECHNOLOGICAL REQUIREMENTS FOR FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)

Technology Needs for Future Missions, Platforms (3)

Author: Dr. Iván Rodríguez Montoya
Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico, ivrguez@gmail.com

IMPLEMENTING INDEPENDENT COMPONENT ANALYSIS TO REMOVE ATMOSPHERIC FOREGROUNDS FROM THE LARGE MILLIMETER TELESCOPE DATA.

Abstract

Implementing Independent Component Analysis to remove atmospheric foregrounds from the Large Millimeter Telescope data.

Ivan Rodriguez-Montoya David Sanchez INAOE, Puebla, Mexico.

With AzTEC (Astronomical Thermal Emission Camera), operating with one band centered at 1.1 mm (272 GHz), on board of the Large Millimeter Telescope on top of the Sierra Negra volcano at Puebla, Mexico, we have a beautiful opportunity to investigate the star formation rate of galaxies on a broad range of redshift distributions. For example, the Sunyaev-Zel'dovich (SZ) effect, among other very interesting physical phenomena like the Cosmic Microwave Background (CMB). However, there are still some foreground removal challenges to be solved in order to obtain the maximum gain of information from AzTEC observations. Particularly, the atmosphere fluctuations are very bright, non-stationary and often abrupt, making very difficult to perform data calibrations. Heuristically, atmospheric emission has an inverse-frequency-like spectrum; but empirically we have verified that it does not only dominates small frequencies, but there remain some atmospheric residuals on intermediate frequencies.

So, the bad news: when removing data contaminated by atmospheric residuals we also lose valuable astrophysical information. Would it be possible to separate both the atmospheric and astrophysical information, minimizing the loss of interesting information? What if we model the signal mixing as a linear superposition of two or more otherwise physically independent components? This way to model the data is called Independent Component Analysis (ICA).

In this project, we handle the problem of atmospheric foreground removal by applying ICA to the AzTEC data. We tackle this one-banded difficulty by proposing a strategy to create artificial redundancy of data in order to apply ICA to our maps. We also propose a recalibration technique to recover the physical fluxes with the use of controlled artificial witnesses. We have tested our ideas with some publicly available astrophysical data and quantified the amount of systematic errors introduced by our approach, to be added in quadratures to the measurement errors. As part of our results, we find that ICA may be very efficient to remove atmospheric residuals with little lose of information, this yields detection of compact sources with important ($> 20\%$) signal-to-noise improvements. Finally, our recalibration approach returns flux systematic errors limited by the map depth. Here we detail our methods and discuss our results.