Spectral Analysis of Meteor Showers using Bayesian Simulation

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Within ESA’s Meteor Research Group, an autonomous meteor observatory is operated at the Canary Islands, named CILBO. The CILBO station has observed meteors in the visual, including corresponding spectra, since 2010. The available data set is large, as its acquisition is based on a frame camera (25fps). A number of tools are available to calibrate the data from raw image frames up to calibrated spectra. These tools include the full calibration pipeline and take care of the radiometric calibration (dark current, flat fielding), the photometric (DN to intensity), as well as the spectral calibration (pixel to wavelength). To obtain the number of atoms or molecules, a plasma radiation model is available to simulate the expected chemical elements, their number density, the temperature regimes at the different locations at the meteor, and the atmospheric contribution. As a meteor is typically several seconds in length and 25 frames are acquired per second, this process is quite cumbersome. As the number of parameters to simulate is large (~5), a brute force method to find a best fit is difficult to achieve. The application of a Bayesian simulation might be a solution to our problem.

This thesis shall analyze and properly phrase our problem. An investigation shall be done in the Bayesian methodology and at least a first attempt shall be tried to compute a good spectral fit using a Bayesian simulation. It is a pre-requisite to have a good theoretical background in statistics and have been exposed to Bayesian statistics.

Reference
Analysis of Energy Spectra with Low Photon Counts via Bayesian Posterior Simulation, by David A. van Dyk