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Studying Aerosol Properties with Astronomical Observations Using a Scattered Moonlight Model

Amy Jones, Stefan Noll, Wolfgang Kausch, Cezary Szyszka, and Stefan Kimeswenger
University of Innsbruck, Astro und Teilchenphysik, Innsbruck, Austria (amy.jones@uibk.ac.at)

We are developing a new technique for monitoring the atmosphere with astronomical observations and our scattered moonlight model. This could be used to determine the size distributions and amounts of various aerosol particles. By taking the Moon as an illuminating source in sky observations, it is possible to iteratively find aerosol properties for a given time and location. There is a wealth of astronomical data over the last decade taken at Cerro Paranal in Chile where this technique can be applied.
Our advanced scattered moonlight model is part of a sky radiance and transmission model developed for the Very Large Telescope of the European Southern Observatory. The moon model can calculate the amount of scattered moonlight present in a given astronomical observation based on the positions of the Moon and target, lunar phase, and atmospheric properties. This model is more physical than previous works in astronomy, which were almost completely empirical. For the original astronomical purpose, the model uses typical size distributions of remote continental tropospheric and stratospheric aerosols and the measured extinction curve from standard star observations to calculate the scattering and absorption of the moonlight to determine the amount of light that would eventually arrive to the telescope. Because the model incorporates the properties of the aerosols, in principle we can use this model with sky background observations to find the aerosol composition. The sky observations would first need to be analysed with our full sky model to calculate the other sky background components, and a derived extinction curve from standard star observations. Then with our moon model we could iteratively find the best aerosol composition for the data. This would require optical and near infrared spectra for an unique, optimized solution.
This technique for studying aerosol properties would provide data from a new perspective. The investigated aerosols would be nocturnal, from a remote location in the Chilean desert, and this method could be extended into the past decade and other locations. Most current methods use the Sun as the illuminating source to study the aerosols and so with this new nocturnal data set one could compare the two types. Additionally, the aerosols near the observatory are not dominated by local pollution sources and the background aerosols can be better studied. Also, the observatory has been operational for over a decade, and the aerosol data set could be extended into the past, as well as the model can be modified so the technique could be applied to other observatories around the globe.
This new method for determining aerosol properties from astronomical observations with our scattered moonlight model could be a promising tool for atmospheric science.