# Combined Reflectance and Emittance Model for Spectral Unmixing

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Spectral unmixing describes a set of techniques which are used to decompose a spectrum of a material mixture into a set of base spectra of the endmembers, i.e. the pure constituents of the mixture. In the field of planetary science, spectral unmixing is employed to assess the mineralogical composition of planetary surfaces usually based on reflectance spectra in the near infrared and thermal infrared region (Hiroi and Pieters 1994, Ramsey and Christensen 1998, Rommel et al. 2017).

In the general case, two types of radiation, i.e. reflected solar radiation and thermally emitted radiation, emerge from the planetary surface and arrive at the spectrometer pointed at the planet. Our unmixing approach attempts to cover the general case which enables unmixing based on of reflectance spectra, emittance spectra and a superposition of reflected and emitted radiation which occurs at the transition zone between reflectance and emittance. The approach is based on Hapke's anisotropic reflectance model (Hapke 2002), which is directional-hermispherically integrated and converted into emittance by using Kirchhoff's law (Wohlfarth et al. 2018). To model the emission, information of the planet's surface temperature is required which is either obtained from measurements or by thermal simulation. The devised technique is particularly useful for the mineralogical analysis of Mercury in view of the upcoming BepiColombo MERTIS data (Hiesinger et al. 2010) and the analysis of lunar spectra in the NIR region mapped by the $M^3$ instrument (Pieters et al. 2009).

We validate our algorithms with spectra measured at the Planetary Spectroscopy Lab (Maturilli et al. 2018) at DLR Berlin and at the IRIS Lab (Morlok et al. 2018) at the Institute for Planetology at Münster University.

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