Relationship between reflectance spectra of meteorites and asteroids visualized by the correlation distance and t-SNE

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Classification of asteroids based on orbits, sizes, and reflectance spectra have been performed for decades to understand the nature of small bodies. As for asteroids, asteroid taxonomic systems based on color, albedo, and spectral shape have been developed and modified/expanded to grasp their variations. While each spectral class is believed to represent a specific composition of asteroids, their correlation is still not fully understood because of the nature of reflectance spectrum of rock-forming minerals; The relationship between reflectance spectra of an asteroid and a meteorite is essentially difficult to unravel without detailed analyses of the shapes of spectra. Even so, several previous attempts exist to statistically solve this issue. For example, Britt et al (1992) successfully produced a map of statistically defined spectral similarities and found that principal component analysis is successful at characterizing the primary spectral variance in the asteroid and meteorite populations. In other words, statistical classifications of spectral types without detailed interpretation of spectral shapes can be useful to overview the variation and relationships within a spectral data set, even though there are known difficulties of comminution, melting, mixing, and space weathering. In this work, we expand the above idea by applying to a wider and denser datasets of reflectance spectra for both meteorites and asteroids. We use published databases of RELAB’s laboratory measurements of meteorites and Planetary Spectroscopy at MIT’s asteroid spectra, which are resampled by cubic spline fits in the wavelengths ranging from 0.45 to 2.45μm with the wavelength resolution of 0.05. We statistically analyze the distance of spectra by means of such as Partial Autocorrelation, Dynamic Time Warping, Pearson Correlation, and Euclidean distance. Results are visualized by using 6 kinds of schemes including t-SNE (t-Stochastic Neighbor Embedding). We find that correlations of both meteorites and asteroids are generally shown by this simple scheme. Preliminary results indicate that (1) V-type asteroids generally match HED meteorites, (2) S-type asteroids locate near ordinary chondrites but they do not entirely match each other, which may reflect the effect of space weathering (3) C-type asteroids match carbonaceous chondrites and they are separated into a few sub clusters.

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