VARIATIONS IN THE NEAR-INFRARED SPECTRA OF THE ENCELADUS PLUME H. Sharma[1], M. M. Hedman[1] and S. Vahidinia[2], [1]University of Idaho, USA (shar9969@vandals.uidaho.edu) and [2]NASA Ames Research Center, USA

Saturn's moon Enceladus has icy particles and water vapor spewing out of a series of fissures located on its South Polar Terrain [1, and references therein]. Studying this plume provides insights into the internal structure and composition of icy worlds [1, and references therein]. In particular, the temporal variability of the plume can help reveal the processes by which plume material is transported from its subsurface water reservoir. For example, a clear peak in plume activity has been observed when Enceladus is near its orbital apocentre in data from both the Visual and Infrared Mapping Spectrometer (VIMS) instrument and Imaging Science Subsystem (ISS) cameras [2, 3, 4]. These variations are likely due to changes in the tidal stresses in Enceladus' south polar terrain [5, 6, 7, 3]. In addition, there is evidence for a long-term decrease in brightness roughly by a factor of 2 that could be due to a long-period tide, buildup of ice at the throat of the vents, or seasonal changes [4], and in 2017 there were significant variations in the plume's activity over the course of a few months [8].

Near-Infrared spectral data from VIMS can provide additional insights into these changes in the plume's activity. VIMS acquires spectra at 352 wavelengths between 0.35 and $5.2\ \mu m$ with two separate channels [9]. The measured integrated brightness at each wavelength is proportional to the surface area of all particles along the line of sight that are efficient at scattering light at those wavelengths. Thus brightness trends with wavelength constrain the particles' size distributions [10, 11, 12]. However, thus far no-one has examined how the plume's spectral properties vary over time.

We have analyzed VIMS spectra from three plume observations taken over a period of 41 days in 2017 at high phase angles ($> 150°$). ISS images taken during this time show that the plume's peak brightness was 10% greater in the middle of the sequence that it was at the beginning or the end for reasons that are still unclear [8]. We will describe the spectral changes of the plume observed by VIMS during these observations. These spectral variations imply that the changes in Enceladus' activity are associated with changes in the size and velocity distribution of the particles escaping Enceladus. We will therefore discuss the implications of these spectral variations for efforts to understand Enceladus' plume activity.

References: **[1]** Paul M Schenk et al. *Enceladus and the icy moons of Saturn*. University of Arizona Press, 2018. **[2]** MM Hedman et al. "An observed correlation between plume activity and tidal stresses on Enceladus". In: *Nature* 500.7461 (2013), pp. 182–184. **[3]** Francis Nimmo, Carolyn Porco, and Colin Mitchell. "Tidally modulated eruptions on Enceladus: Cassini ISS observations and models". In: *The Astronomical Journal* 148.3 (2014), p. 46. **[4]** Andrew P Ingersoll and Shawn P Ewald. "Decadal timescale variability of the Enceladus plumes inferred from Cassini images". In: *Icarus* 282 (2017), pp. 260–275. **[5]** Francis Nimmo et al. "Shear heating as the origin of the plumes and heat flux on Enceladus". In: *Nature* 447.7142 (2007), pp. 289–291. **[6]** TA Hurford et al. "Eruptions arising from tidally controlled periodic openings of rifts on Enceladus". In: *Nature* 447.7142 (2007), pp. 292–294. **[7]** TA Hurford, P Helfenstein, and JN Spitale. "Tidal control of jet eruptions on Enceladus as observed by Cassini ISS between 2005 and 2007". In: *Icarus* 220.2 (2012), pp. 896–903. **[8]** Andrew P Ingersoll, Shawn P Ewald, and Samantha K Trumbo. "Time variability of the Enceladus plumes: Orbital periods, decadal periods, and aperiodic change". In: *Icarus* 344 (2020), p. 113345. **[9]** Robert H Brown et al. "The Cassini visual and infrared mapping spectrometer (VIMS) investigation". In: *Space Science Reviews* 115.1-4 (2004), pp. 111–168. **[10]** MM Hedman et al. "Spectral observations of the Enceladus plume with Cassini-VIMS". In: *The Astrophysical Journal* 693.2 (2009), p. 1749. **[11]** Andrew P Ingersoll and Shawn P Ewald. "Total particulate mass in Enceladus plumes and mass of Saturn's E ring inferred from Cassini ISS images". In: *Icarus* 216.2 (2011), pp. 492–506. **[12]** Carolyn Porco, Daiana DiNino, and Francis Nimmo. "How the geysers, tidal stresses, and thermal emission across the south polar terrain of Enceladus are related". In: *The Astronomical Journal* 148.3 (2014), p. 45.