JWST Spectra of the Inner Oort Cloud Dwarf Planet (90377) Sedna. J.P. Emery[1], J.C. Cook[2], N. Pinilla-Alonso[3], J.A. Stansberry[4], I. Wong[5], B.J. Holler[4], S. Protopapa[6], W.M. Grundy[7], R. Brunetto[8], A.C. Souza-Feliciano[3], E. Fernández-Valenzuela[3], D.C. Hines[4]. [1]Northern Arizona University (joshua.emery@nau.edu), [2]Pinhead Institute, [3]Florida Space Institute, [4]Space Telescope Science Institute, [5]NASA Goddard Spaceflight Center, [6]Southwest Research Institute, [7]Lowell Observatory, [8]Institut d'Astrophysique Spatiale, Université Paris-Saclay, CNRS.

Introduction: The dwarf planet (90377) Sedna is the largest of the three known members of the Inner Oort Cloud (IOC) population [1,2]. The perihelion distances of IOC objects are so large that current gravitational interactions with the giant planets are negligible. IOCs may be objects that formed in the Kuiper Belt and were scattered outward, either by planet-sized objects (which themselves may have been ejected or may remain undetected in the distant Solar System) or by a close stellar encounter. Another possibility is that IOCs were captured by the Sun after being ejected by other stars in its birth cluster [2, 3, 4].

Ground-based visible and near-infrared (NIR; 0.4 to 2.5 μm) spectra of Sedna show an absorption band near 2.3 μm ascribed to CH_4 and/or CH_3OH ice, hints of H_2O ice and a steep red spectral slope suggestive of complex organics [5, 6]. Photometry at 3.6 and 4.5 μm measured with the Infrared Array Camera (IRAC) on the Spitzer Space Telescope indicates strong absorption bands relative to the 2-μm region and support spectral models that include H_2O ice and simple hydrocarbons [7]. However, the low S/N of the NIR spectra and photometric nature of the IRAC data hinder detailed compositional analysis. With equilibrium temperatures of ~30 K and ~9 K at perihelion (~76AU) and aphelion (~937 AU), respectively, a wide range of ices should be stable on the surface.

More detailed knowledge of the surface composition of Sedna, particularly in comparison with other Trans-Neptunian Objects (TNOs), would provide important constraints on the origin and evolutionary processes of Sedna and other IOCs. Many of the organics and ices thought to exist on Sedna's surface exhibit strong absorption in the 2- to 5-μm wavelength range. High quality spectra at these wavelengths would therefore reveal new information about Sedna's composition.

Observations: Sedna was observed by the James Webb Space Telescope (JWST) using the NIRSpec IFU in prism mode. The observations were part of GTO program 1272 (PI D. Hines) and occurred on Sept 13, 2022 (17:18-17:49 UT). The spectrum covers the wavelength range 0.7–5.3 μm with a spectral resolving power of ~100, significantly extending the wavelength range of spectral coverage available from the ground.

Data were extracted using a combination of the JWST NIRSpec pipeline and additional custom routines for better handling of readnoise, hot pixels, and cosmic ray artifacts. We have also implemented empirical PSF-fitting for extracting high-precision spectra.

Results: The JWST spectrum contains a wealth of information about the surface composition of Sedna. At $\lambda < 2.5$ μm, the spectrum has much higher S/N than previously published ground-based spectra, revealing diagnostic structure not visible in the ground-based observations. H_2O ice bands suggested in the ground-based spectra at 1.5 and 2.0 μm are confirmed, and distortions of the band shapes indicate significant contamination of the ice by other materials. The absorption band complex near 2.3 μm is revealed with significant substructure that will enable a detailed analysis of the species responsible.

At $\lambda > 2.5$ μm, the overall level of reflectance is consistent with the Spitzer/IRAC photometry. A broad and deep absorption from ~2.8 to 3.5 μm is likely due to H_2O ice, as is a gentle curvature at ~4–5 μm. Several narrower absorption bands throughout the NIRSpec prism wavelength range are consistent with ethane (C_2H_6) ice, including a very strong absorption complex near 3.4 μm. Interestingly, the strong absorption from methane (CH_4) at 3.3 μm is not apparent in the spectrum.

Discussion: We will present the JWST spectrum of Sedna in the context of the previous ground-based and Spitzer data and will present new spectral analyses. Eventually, comparison of the composition of Sedna to other dynamical classes of Trans-Neptunian Objects (TNOs) will address the context of IOC objects within the TNO population.

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