Compositional Analysis of Titan's Atmosphere Using Spitzer Infrared Spectrograph Data Brandon Park Coy[12] (bpcoy@uchicago.edu), Conor A. Nixon[2], Naomi Rowe-Gurney[3], Richard Achterberg[124], Leigh N. Fletcher[3], and Patrick Irwin[5] [1]Center for Research and Exploration in Space Science & Technology, [2]Planetary Systems Laboratory, NASA Goddard Space Flight Center, [3]School of Physics and Astronomy, University of Leicester, [4]Department of Astronomy, University of Maryland, [5]Department of Physics, University of Oxford

Introduction: We present, for the first time, infrared spectra from the Spitzer Space Telescope's Infrared Spectrograph (IRS) (2004-2008) [1] of Titan in both the short wavelength-low resolution (SL, R=60~127, 5.13-14.29 μm) and short wavelength-high resolution (SH, R=600, 9.89-19.51 μm) channels showing the emissions of CH_4, C_2H_4, C_2H_2, C_2H_6, HCN, CO_2, HC_3N, C_3H_4, C_4H_2, and C_3H_8.

Spitzer IRS data has been used to measure atmospheric composition of various Solar System bodies, including Neptune [2] and Uranus [3][4]. Although Spitzer took multiple dedicated observations of Titan, none of the results have been modeled before. We conduct our own investigation of these datasets and search for new results.

We retrieve temperature and gas composition profiles using the Non-linear Optimal Estimator for MultivariatE Spectral analySIS (NEMESIS) planetary atmosphere radiative transfer and retrieval tool [5] and compare the results obtained for Titan to those of the Cassini Composite Infrared Spectrometer (CIRS) and the Infrared Space Observatory Short Wavelength Spectrometer [6], and comment on the effect of spectral resolution on retrieved information content. We also calculate upper constraints on exotic species theorized to be produced in Titan's upper atmosphere, such as C_{60}.

We conclude by recommending gaps in current spectroscopic knowledge of molecular bands that could be addressed by theoretical and laboratory study to aid future astronomical studies of Titan, for example the James Webb Space Telescope (JWST) and the Stratospheric Observatory for Infrared Astronomy (SOFIA)

Acknowledgments: Data analyzed in this project is public available online on the Spitzer Heritage Archive (sha.ipac.caltech.edu). This research has made use of the NASA/IPAC Infrared Science Archive, which is funded by the National Aeronautics and Space Administration and operated by the California Institute of Technology. Coy and Nixon were funded by the NASA Astrobiology Institute. Rowe-Gurney was supported by a European Research Council Consolidator Grant (under the EU's Horizon 2020 research and innovation program, grant agreement No. 723890) at the University of Leicester).

References::

[1] Houck et al. (2004), *The Astrophysical Journal Supplement Series, Vol. 154, 18-24.* [2] Meadows et al. (2008) *Icarus, Vol. 197 Issue 2,* 585-589. [3] Orton et. al (2014) *Icarus, Vol. 243,* 494–513. [4] Rowe-Gurney et al. (2021) *Icarus, 114506.* [5] Irwin et al. (2008) *Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 109 Issue 6, 1136-1150.* [6] Coustenis et al. (2003) *Icarus, Vol. 161 Issue 2,* 383-403.