

Principal Investigator, Dr. Keeyoon Sung

Scientist

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H-Index = 28; Publications = 103; Times cited = 8,762

Relevant Experience: His specialties are laboratory atmospheric molecular spectroscopy, atmospheric remote sensing with FT-IR, and spectrum fitting algorithm developments. At JPL he has maintained and characterized a state-of-the-art high-resolution Fourier-transform spectrometer, Bruker IFS-125HR. Since 2007, he has conducted laboratory spectroscopic measurements on many atmospheric molecules (HDO, CO₂, ¹⁴NH₃, OCS, CH₄, C₃H₈, C₆H₆, CH₃CN, and many others) in support of Earth and Planetary atmospheric remote sensing. In particular, he produced quality reference spectrum data for the analysis of Cassini/CIRS spectral observations, one of which led to the first detection of propylene (C₃H₆) in Titan by the Co-I (Nixon). Under his management, the high-resolution Fourier transform spectrometer (Bruker 125HR) has become a major research asset for molecular spectroscopy at JPL. He has published more than 100 peer-reviewed articles and has been a regular contributor to the HITRAN database since 2009.

Education

- Ph.D. in Atmospheric Sciences, Stony Brook University (2003)
Thesis: “*Lab. Measurements of the Infrared Spectra of Planetary Atmospheric Trace Gases*”
- Course Completion in Astronomy (M.Sc), Seoul National University, Korea (1998)
- B.Sc., Cum Laude, in Astronomy & Space Science, Chungnam Nat'l Univ., Korea (1996)

Research Experience

- Research scientist, Science Division, JPL, California Institute of Technology (2010 – present)
- Post-doctoral fellow, Science Division, JPL, California Institute of Technology (2007 – 2010)
- Post-doctoral fellow, Dept. of Physics, University of Toronto, Canada (2006 – 2007)
- Post-doctoral fellow, Dept. of Chemistry, University of Waterloo, Canada (2003 – 2006)

Awards and honors

- Group Award to OCO-2 Algorithm Team (2020)
- Voyager award for proposal successes and quality research in the planetary science (2018)
- Group Award to OCO-2 Algorithm Team (2016)
- Group Achievement Award to Stratosphere Atmospheric Measurement Team (2015)
- Group Award for OCO-2 Algorithm Development (2014)
- Group Award to OCO-2 Science Implementation Team (2012)

On-going and completed NASA-ROSES projects (as Principal Investigator)

- [CDAP 2023] The Mystery of Titan's ‘Missing’ Nitriles
- [XRP 2020] Adaptation of high precision atmospheric trace gas retrieval technique and updated spectroscopy to model micro-telluric features enabling EPRV

- [CDAP 2017] Search for elusive high mass hydrocarbon and nitriles in the Titan stratosphere
- [PDART 2016] Laboratory study of far-IR HD spectroscopy and mid-IR H₂-H₂ collision-induced absorption for Jovian atmospheres
- [PATM 2013] Laboratory study of mid-IR propene for Titan and near-IR methane for planets

SELECTED PUBLICATIONS:

Laboratory Spectroscopy

- Scott C. Egbert, **Keeyoon Sung**, Sean C. Coburn, Brian J. Drouin, Gregory B. Rieker. Water-vapor absorption database using dual comb spectroscopy from 300 to 1300 K part I: Pure H₂O, 6600 to 7650 cm⁻¹. JQSRT, 318 (2024). 108940. <https://doi.org/10.1016/j.jqsrt.2024.108940>
- Robert R. Gamache, Nicholas Orphanos, Bastien Vispoel, **Keeyoon Sung** and Geoffrey C. Toon. Measurements of H₂O-O₂ line shape parameters and the determination of the intermolecular potential for modified complex Robert-Bonamy calculations. MOLECULAR PHYSICS e2281592. <https://doi.org/10.1080/00268976.2023.2281592>
- A.V. Nikitin, A. Campargue, A.E. Protasevich, M. Rey, **K. Sung**, V.I.G. Tyuterev. Analysis of experimental spectra of phosphine in the Tetradecad range near 2.3 μm using ab initio calculations. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. 302, 122896 (2023).
- B. Steffens, **K. Sung**, et al. Pseudoline generation for trans-2-butene in the 7-15 μm region in support of Titan atmosphere study. Journal of Quantitative Spectroscopy & Radiative Transfer 310 (2023) 108730. <https://doi.org/10.1016/j.jqsrt.2023.108730>
- Gordon IE, Rothman LS, et al., **Keeyoon Sung**, et al. *The HITRAN 2020 molecular spectroscopic database*. J Quant. Spectrosc. Radiat. Transfer 277 (2022) 107949.
- H.S.P. Mueller, Arnaud Belloche, Frank Lewen, Brian Drouin, **Keeyoon Sung**, et al. *Toward a global model of the interactions in low-lying states of methyl cyanide: Rotational and rovibrational spectroscopy of the ν₄ = 1 state and tentative interstellar detection of the ν₄ = ν₈ = 1 state in Sgr B2(N)*. J. Mol. Spectrosc. 378, 111449 (2021).
- **K. Sung**, B. Steffens, G. C. Toon, et al. *Pseudoline parameters to represent n-Butane(n-C₄H₁₀) in the 7 – 15 μm region for the Titan atmospheres*. JQSRT, 251 (2020) 107011.
- Kirstin D. Doney, Vincent Kofman, Geronimo Villanueva, **Keeyoon Sung**. *A new model of monodeuterated ethane (C₂H₅D) spectrum: Enabling sensitive constraints on the D/H in ethane emission in comets*. JQSRT, 255 (2020) 107225.
- **K. Sung**, E.H. Wishnow, T.J. Crawford, et al. *FTS measurements of O₂ collision-induced absorption in the 565–700 nm region using a high pressure gas absorption cell*, JQSRT, 235, 232-243 (2019).
- **Sung K**, Toon GC , Drouin BJ , Mantz AW , Smith MAH . *FT-IR measurements of cold propene (C₃H₆) cross-sections at temperatures between 150 and 299K*. J Quant Spectrosc Radiat Transfer 2018:119–32 .
- **Sung K**, Toon GC, et al. *N₂- and (H₂+He)-broadened cross sections of benzene (C₆H₆) in the 7 – 15 μm region for the Titan and Jovian atmospheres*. Icarus 271: 438–452 (2016).
- **Sung K**, Yu S, Pearson J, et al. *Far-infrared ¹⁴NH₃ line positions and intensities measured with an FT-IR and AILES beamline, Synchrotron SOLEIL*. J. Mol. Spectrosc. 327, 1– 20 (2016).
- **Sung K**, Toon GC, Mantz, AW, Smith MAH. *FT-IR measurements of cold C₃H₈ cross sections at 7 - 15 μm for Titan atmosphere*. Icarus, 226, 1499 – 1513 (2013).

- **Sung K**, Brown LR, Huang X, Schwenke DW, Lee TJ, Coy SL, Lehmann KK. *Extended line positions, intensities, empirical lower state energies, and quantum assignments of NH₃ from 6300 to 7000 cm⁻¹*. J. Quant. Spectrosc. Radiat. Transfer 113, 1066 – 1083 (2012).

✚ Planetary science (including Contributions to Decadal survey)

- Brendan L. Steffens , Conor A. Nixon , **Keeyoon Sung** , Patrick G. J. Irwin, Nicholas A. Lombardo, Eric Pereira. New Constraints on Titan's Stratospheric n-Butane Abundance. Planetary Science Journal, 3:59 (2022). <https://doi.org/10.3847/PSJ/ac53ad>
- D.W. Savin, ..., **Sung K**, et al. Astro 2020 Science White Paper, *State of the Profession Considerations for Laboratory Astrophysics*. National Academy of Science (2019).
- J. Fortney, ..., **Sung K**, et al. Astro 2020 Science White Paper, *The Need for Laboratory Measurements and Ab Initio Studies to Aid Understanding of Exoplanetary Atmospheres*, National Academy of Science (2019)
- Anglada-Escude G, Plavachan P, ..., **Sung K**, et al. *Design and Construction of Absorption Cells for Precision Radial Velocities in the K Band Using Methane Isotopologues*, Pub. Astron. Soc. Pacific, 124, 586 – 597 (2012).
- Lombardo NA, Nixon CA, ..., **Sung K**, et al. *Spatial and seasonal variations in C₃H_x hydrocarbon abundance in Titan's stratosphere from Cassini CIRS observations*. Icarus 317: 454-469 (2019).
- Nixon CA, Jennings DE, ..., **Sung K**, et al. *Detection of propene in Titan's atmosphere*, Astrophys. J. Lett. 776, L14 (2013).
- J. L. Fox and **K. Sung**. *Solar activity variations of the Venus thermosphere/ ionosphere*. J. Geophys. Res., 106, 21305 – 21335 (2001)
- Y. H. Kim, **K. Sung**, S. J. Kim, W. D. Cochran, D. F. Lester, L. Trafton, B. E. Clark. *An analysis of infrared images of Jupiter impacted by P/Shoemaker-Levy 9*. J. Korean Astron. Soc., 29, 245 – 253 (1996).

✚ Earth Atmospheric Remote Sensing

- Zhao-Cheng Zeng , Olivia Addington , Thomas Pongetti, Robert L. Herman , **Keeyoon Sung** , Sally Newman , Andreas Schneider , Tobias Borsdorff, Yuk L. Yung , Stanley P. Sander , Remote sensing of atmospheric HDO/H₂O in southern California from CLARS-FTS, Quant. Spectrosc. Radiat. Transfer (2022). <https://doi.org/10.1016/j.jqsrt.2022.108254>
- Toon GC, Blavier J-F, **Sung K**, Yu K. *Spectrometric measurements of atmospheric propane(C₃H₈)*. Atmos. Chem. Phys. Discussion (2020). <https://doi.org/10.5194/acp-2020-1135>
- Toon GC, Blavier J-F, **Sung K**. *Measurements of atmospheric ethene by solar absorption FTIR spectrometry*. Atmos. Chem. Phys. 18, 1 – 14 (2018). <https://doi.org/10.5194/acp-18-1-2018>.
- Drouin B, Benner, et al., Sung K, et al. *Multispectrum analysis of the oxygen A-band*, J. Quant. Spectrosc. Radiat. Transfer, 186, 118-138 (2017)