

# Shanshan Yu

shanshan.yu@jpl.nasa.gov  
(818) 354-5829 (work)

Small Bodies Group, Planetary Science Section  
Science Division, Jet Propulsion Laboratory  
California Institute of Technology  
4800 Oak Grove Drive, Pasadena, CA, 91109, USA

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## Education

- B.Eng. in optoelectronics, East China Normal University, China (2000)
- M.Sc. in optics, East China Normal University, China (2003)
- Ph.D. in physical chemistry, University of Waterloo, Canada (2007)

## Professional Experience

- Graduate research assistant (2003-2007), University of Waterloo, Canada
- Postdoctoral scholar (2007), University of Waterloo, Canada
- NASA Postdoctoral Program Scholar, JPL Earth Science section (2008-2009)
- Research Scientist, JPL Earth Science section and Planetary Science section (2010-Present)
  - OCO-3 Instrument Calibration Team Member (2017-present)
  - OCO-2 Instrument Calibration Team Member (2017-present)
  - OCO-2 ABSCO Team Member (2014-2016)
  - Herschel observations of EXtra-Ordinary Sources (HEXOS) Team Member (2010-2014)
  - PRobing InterStellar Molecules with Absorption line Studies Team Member (2010-2014)
  - Herschel/HIFI Instrument Team Member (2010-2014)
  - JPL Molecular Spectroscopy Team Member (2010-present)
- Program Manager, JPL Planetary Instrument Research and Technology Office (2020-present)
  - Discipline Program Manager (DPM), Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO)
  - DPM, Maturation of Instruments for Solar System Exploration (MATISSE)
  - DPM, Development and Advancement of Lunar Instrumentation Program (DALI)
  - DPM, Instrument Concepts for Europa Exploration 2 (ICEE2)
  - DPM, Planetary Science and Technology Through Analog Research (PSTAR)
  - DPM, Planetary Science Enabling Facilities (PSEF)

**Research Specialty:** mm-Submm-THz-IR-Visible-UV molecular spectroscopy focused on composition of Earth's atmosphere, planetary atmospheres, and the interstellar medium

## Peer-reviewed Publications as of May 18, 2022

- 96 peer-reviewed publications; 4549 total citations, complete list attached at the end of CV
- Web of Science H-index: 32 (<http://www.researcherid.com/rid/D-8733-2016>)

## Funded Research Projects

- PI: ROSES/PICASSO (2017-2020), *“Millimeter-wave spectrometer for chirality and relative abundance determination of amino acid biomarkers (ChiralSpec)”*
- PI: JPL/Spontaneous R&TD (2016), *“Laboratory measurements to enable advances in remote sensing of near-surface CH<sub>4</sub> concentrations”*
- PI: ROSES/APRA (2013-2016), *“Study of NH<sub>3</sub> line intensities in the THz and Far-IR region”*
- PI: JPL/Spontaneous R&TD (2013), *“Development of a novel apparatus for simulating the interstellar medium”*
- PI: French National Synchrotron Facility (2013), *“Spectroscopy of far-IR NH<sub>3</sub> transitions involving 3  $\nu_2$  and higher vibrational states: using evolution of spectra from 200 K to 350 K to empirically estimate lower state energies”*
- PI: French National Synchrotron Facility (2010), *“Measurement of positions and intensities of the ground,  $\nu_2$ , 2  $\nu_2$  and  $\nu_4$  inversion bands of ammonia”*
- CO-I: ROSES/ACLS (2021-2024), *“Molecular Spectroscopy in Support of Atmospheric Research”*
- CO-I: ROSES/ACLS (2018-2021), *“Molecular Spectroscopy in Support of Atmospheric Research”*
- CO-I: ROSES/ACLS (2015-2018), *“Millimeter and submillimeter spectroscopy in support of atmospheric research”*
- CO-I: ROSES/ACLS (2011-2014), *“Millimeter and submillimeter spectroscopy in support of upper atmospheric research”*
- CO-I: ROSES/APRA (2010-2013), *“Systematic spectroscopy on the primary sources of interstellar lines”*
- CO-I: JPL/Spontaneous R&TD (2015), *“First direct measurements of global atmospheric isoprene from satellite observations”*
- CO-I: European Southern Observatory observing programs (2019), *“ESPRESSO observations of the 4LGSF up-link laser beams: detailed characterization of the Raman spectral contamination from laser guide star systems on AO instruments”*
- CO-I: Herschel Open Time Cycle-1 (OT1) Observations (2010), *“Investigation of the nitrogen chemistry in diffuse and dense interstellar gas”*
- CO-I: Herschel Open Time Cycle-2 (OT2) Observations (2010), *“Probing the Unique Environment Around Sgr A\*”*

## Honors and Awards

- OCO-3 Science Team Award, JPL Earth Science and Technology directorate (2021)
- NASA Group Achievement Award to OCO-3 Project System Engineering team (2020)
- Voyager Award, JPL Planetary Science directorate (2020)
  - For helping ROSES funded instrument tasks obtain COVID restart access
- OCO-3 Science Team Award, JPL Earth Science and Technology directorate (2019)
- OCO-3 Integration & Test Team Award, JPL Earth Science and Technology directorate (2019)

- Voyager Award, JPL Planetary Science directorate (2017)
  - For winning ROSES16 PICASSO proposal award
- Voyager Award, JPL Science Division (2015)
  - For contribution in the field of molecular spectroscopic research leading to the receipt of the prestigious 2015 Flygare Award
- Flygare Award, International Symposium on Molecular Spectroscopy (2015)
  - For outstanding contributions in molecular spectroscopy by an early career scientist
  - Established in 2015, Awarded to four scientists in 2015, two in 2017, two in 2019
- NASA Group Achievement Award to U.S. Herschel HIFI Instrument Team (2014)
  - For outstanding calibration and analysis support provided to the Herschel HIFI Instrument Control Center that enabled a superbly operating instrument until the end of mission
- Peer Reviewing Excellence, Elsevier and Journal of Molecular Spectroscopy (2014)
  - In recognition of an outstanding contribution to the quality of the journal
- Elsevier JQSRT Outstanding Young Scientist Award in Quantitative Spectroscopy (2010)
  - Given to one young scientist on a biennial basis
- NASA Postdoctoral Program Fellowship at Jet Propulsion Laboratory (2008-2009)
- F.W. Karasek Scholarship, University of Waterloo, Chemistry Department (2007)
  - Awarded annually to a graduate student registered in the chemistry department based on ability and promise in research and performance in courses
- Ontario Graduate Scholarship (2006-2007)
  - Funded by the Province of Ontario, Canada
  - Awarded to students at Master's and doctoral levels in all disciplines of academic study
  - 3000 scholarships awarded annually, 90 of these awarded to visa students such as me
- The University of Waterloo President's Graduate Scholarship (2006-2007)
- H.G. McLeod Scholarship, University of Waterloo, Chemistry Department (2006)
  - Awarded annually to a graduate student registered in the chemistry department on the basis of overall abilities, including both research and course work
- Chinese Government Award for Outstanding Self-Financed Students Abroad (2005)
  - Granted annually to ~500 self-financed Chinese students studying overseas

### **Selected Professional Services**

- Editor, Journal of Molecular Spectroscopy (2013-2016)
- Member of steering committee: Network FOFor Life Detection (NfoLD) (2019-present)
- Member of the International Advisory Committee for the International Symposium on Molecular Spectroscopy (ISMS) (2016-2019)
- Organizer for mini-symposium in ISMS (2018)
- Section chair for ISMS, Spectral line lists (2015), Microwave (2012)
- Judge for the Rao Prize, ISMS (2012)

- Journal article reviewer: *Frontiers in Astronomy and Space Sciences*, *Astrophysical Journal*, *Journal of Quantitative Spectroscopy & Radiative Transfer*, *Journal of Molecular Spectroscopy*, *Chemical Physics Letters*

## Peer-reviewed Publications

97. F. P.A. Vogt, A. Mehner, P. Figueira, **S. Yu**, F. Kerber, T. Pfrommer, W. Hackenberg and D.B. Calia, “The pure-rotational and rotational-vibrational Raman spectrum of the atmosphere at an altitude of 23 km”, in preparation (2022).
96. J. Pearson, B.J. Drouin and **S. Yu**, “Instrumentation for THz spectroscopy in the laboratory and in space”, *IEEE Journal of Microwaves*, **1**, 43 (2021).
95. T. E. Taylor, A. Eldering, A. Merrelli, M.Kiel, P. Somkuti, C. Cheng, R. Rosenberg, B. Fisher, D. Crisp, R. Basilio, M. Bennett, D. Cervantes, A. Chang, L. Dang, C. Frankenberg, V. R. Haemmerle, G. R. Keller, T. Kurosu, J. L. Laughner, R. Lee, Y. Marchetti, R. R. Nelson, C. W. O'Dell, G. Osterman, R. Pavlick, C. Roehl, R. Schneider, G. Spier, C. To, C. Wells, P. O. Wennberg, A. Yelamanchili, **S. Yu**, “OCO-3 early mission operations and initial (vEarly) XCO<sub>2</sub> and SIF retrievals”, *Remote Sensing of Environment* **251**, 112032 (2020).
94. **S. Yu**, R. Rosenberg, C. Bruegge, L. Chapsky, D. Fu, R. Lee, T. Taylor, H. Cronk, C. O’Dell, A. Angal, J. Xiong, D. Crisp, and A. Eldering, “Stability Assessment of OCO-2 Radiometric Calibration Using Aqua MODIS as a Reference”, *Remote Sensing* **12**, 1269 (2020).
93. T. Furtenbacher, P. A. Coles, J. Tennyson, S. N.Yurchenko, **S. Yu**, B. Drouin, R. Tobias, A. G. Csaszar, Empirical rovibrational energy levels of ammonia up to 7500 cm<sup>-1</sup>”, *JQRST* **251**, 107027 (2020).
92. D. Fu, D.B. Millet, K.C. Wells, V.H. Payne, **S. Yu**, A. Guenther, A. Eldering, “Direct retrieval of isoprene from satellite-based infrared measurements”, *Nature Communications*, **10**, 3811 (2019).
91. F. P.A. Vogt, F. Kerber, A. Mehner, **S. Yu**, T. Pfrommer, G.e Lo Curto, P. Figueira, D. Parraguez, “Rotational and ro-vibrational Raman spectroscopy of air to calibrate astronomical spectrographs”, *Phys. Rev. Lett.* **123**, 061101 (2019).
90. K. Sung, E.H. Wishnow, T.C. Timothy, D. Nemchick, B.J. Drouin, G.V. Toon, **S. Yu**, V. Payne and J.H. Jiang, “FTS measurements of O<sub>2</sub> collision-induced absorption in the 565–700 nm region using a high-pressure gas absorption cell”, *J. Quant. Spectrosc. Radiat. Transf.* **235**, 232 (2019).
89. C.J. Bruegge, D. Crisp, M C. Helmlinger, F. Kataoka, A. Kuze, R. A. Lee, J. L. McDuffie, R. A. Rosenberg, F. M. Schwandner, K. Shiomi, and **S. Yu**, “Vicarious Calibration of Orbiting Carbon Observatory-2 (OCO-2)”, *Transactions on Geoscience and Remote Sensing*, **57**, 5135 (2019).
88. R. Rosenberg, G. Spiers, R. Lee, **S. Yu**, D. Crisp, A. Eldering, S. Maxwell, “Coming soon: OCO<sub>3</sub>”, *GSICS Quarterly: Fall Issue 2018, Volume 12, No. 2, 2018* (DOI: 10.25923/xy6e-xt67).
87. J. Pearson, **S. Yu**, J. Pearson, K. Sung, B. Drouin, O. Pirali, “Extended measurements and an experimental accuracy effective Hamiltonian model for the 3ν<sub>2</sub> and ν<sub>4</sub>+ν<sub>2</sub> states of ammonia”, *J. Mol. Spectrosc.* **353**, 60, 2018.
86. **S. Yu**, B.J. Drouin, J.C. Pearson and T. Amano, “THz Spectroscopy of <sup>12</sup>CH<sup>+</sup>, <sup>13</sup>CH<sup>+</sup>, and <sup>12</sup>CD<sup>+</sup>: A combined Dunham analysis of Terahertz lines and A1\Pi- X1\Sigma<sup>+</sup> transitions”, *J. Mol. Spectrosc.* **350**, 30, 2018.
85. F. Oyafuso, V.H. Payne, B.J. Drouin, V. Malathy Devi, D. Chris Benner, K. Sung, **S. Yu**, I.E. Gordon, R. Kochanov, Y. Tan, Da. Crisp, E.J. Mlawer, A. Guillaum, “High accuracy absorption coefficients for the Orbiting Carbon Observatory-2 (OCO-2) mission: Validation of updated carbon dioxide cross-sections using atmospheric spectra”, *J. Quant. Spectrosc. Radiat. Transf.* **203**, 213 (2017).
84. I. E. Gordona, L.S. Rothman, C. Hill, R.V.Kochanov, Y. Tan, P.F. Bernath, M. Birk, V. Boudon, A. Campargue, K.V. Chance, B.J. Drouin, J.-M. Flaud, R.R. Gamache, J.T. Hodges, D. Jacquemart, V.I. Perevalov, A. Perrin, K.P. Shine, M.-A.H. Smith, J. Tennyson, G.C. Toon, H. Tran, V.G. Tyuterev, A.

- Barbe, A. Csaszar, M.V. Devi, T. Furtenbacher, J.J. Harrison, A. Jolly, T. Johnson, T. Karman, I. Kleiner, A.A. Kyuberis, J. Loos, O. M. Lyulin, S. T. Massie, S.N. Mikhailenko, N. Moazzen-Ahmadi, H.S.P. Müller, O.V. Naumenko, A.V. Nikitin, O.L. Polyansky, M. Rey, M. Rotger, S. Sharpe, K. Sung, E. Starikova, S.A. Tashkun, J. Vander Auwera, G. Wagner, J. Wilzewski, P. Wcisło, **S. Yu**, E.J. Zak, "The HITRAN2016 Molecular Spectroscopic Database", *J. Quant. Spectrosc. Radiat. Transf.* 203, 3 (2017).
83. B.J. Drouin, T.J. Crawford, and **S. Yu**, "Validation of ozone intensities at 10 micron with THz spectrometry", *J. Quant. Spectrosc. Radiat. Transf.* 203,282 (2017).
82. **S. Yu**, J.C. Pearson, T. Amano and F. Matsushima, "THz spectroscopy of  $D_2H^+$ ", *J. Mol. Spectrosc.* 331, 6 (2017).
81. B.J. Drouin, D.C Benner, L.R. Brown, M.J. Cich, T.J. Crawford, V.M. Devi, A. Guillaume, J.T. Hodges, E.J. Mlawer, D.L Robichaud, F. Oyafuso, V.H. Payne, K. Sung, E.H. Wishnow, and **S. Yu**, "Multispectrum analysis of the oxygen A-band", *J. Quant. Spectrosc. Radiat. Transf.* 186, 118 (2017).
80. **S. Yu**, I.E. Gordon and P.N. Roy, "Potentiology and spectroscopy in honor of Robert Le Roy: A preface to the special issue", *J. Mol. Spectrosc.* 330, 1 (2016).
79. N. Jacquinet-Husson, R. Armante, N.A. Scott, A. Chédin, L. Crépeau, C. Boutammine, A. Bouhdaoui, C. Crevoisier, V. Capelle, C. Boone, N. Poulet-Crovisier, A. Barbe, D. Chris Benner, V. Boudon, L.R. Brown, J. Buldyreva, A. Campargue, L.H. Coudert, V.M. Devi, M.J. Down, B.J. Drouin, A. Fayt, C. Fittschen, J.-M Flaud, R.R. Gamache, J. J. Harrison, C. Hill, D. Jacquemart, E. Jiménez, A. Jolly, N. Lavrentieva, L. Lodi, Ø. Hodnebrog, A. Makie, S.T. Massie, S. Mikhailenko, H.S.P. Müller, O.V. Naumenko, A. Nikitin, C.J. Nielsen, J. Orphal, V. Perevalov, A. Perrin, E. Polovtseva, A. Predoi-Cross, M. Rotger, A. A. Ruth, **S. Yu**, K. Sung, S. Tashkun, J. Tennyson, V.I. Tyuterev, J. Vander Auwera, B. Voronin, "The 2015 edition of the GEISA spectroscopic database", *J. Mol. Spectrosc.* 327, 31 (2016).
78. D. Fu, K.W. Bowman, H.M. Worden, V. Natraj, J.R. Worden, **S. Yu**, P. Veefkind, I. Aben, J. Landgraf, L. Strow, and Y. Han, "High-resolution tropospheric carbon monoxide profiles retrieved from CrIS and TROPOMI", *Atmos. Meas. Tech.* 9, 2567 (2016).
77. **S. Yu**, J.C. Pearson, B.J. Drouin, C.E. Miller, K. Kobayashi and F. Matsushima, "Terahertz spectroscopy of ground state  $HD^{18}O$ ", *J. Mol. Spectrosc.* 328, 27 (2016).
76. J.C. Pearson, **S. Yu**, O. Pirali, "Modeling the spectrum of the  $2\nu_2$  and  $\nu_4$  states of ammonia to experimental accuracy", *J. Chem. Phys.* 145, 124301 (2016).
75. K. Sung, **S. Yu**, J. Pearson, O. Pirali, F. Kwabia Tchana and L. Manceron, "Far-infrared  $^{14}NH_3$  line positions and intensities measured with a FT-IR and AILES beamline, Synchrotron SOLEIL", *J. Mol. Spectrosc.* 327, 1 (2016).
74. D.C Benner, V.M. Devi, K. Sung, L.R. Brown, C.E. Miller, V.H. Payne, B.J. Drouin, **S. Yu**, T.J. Crawford, A.W. Mantz and M.A.H. Smith, "Line parameters including temperature dependences of self- and air-broadened line shapes of  $^{12}C^{16}O_2$ : 2.06- $\mu m$  region", *J. Mol. Spectrosc.* 321, 21 (2016).
73. V.M. Devi, D.C Benner, K. Sung, L.R. Brown, T.J. Crawford, C.E. Miller, B.J. Drouin, V.H. Payne, **S. Yu**, M.A.H. Smith and A.W. Mantz, "Line parameters including temperature dependences of self- and air-broadened line shapes of  $^{12}C^{16}O_2$ : 1.6- $\mu m$  region", *J. Quant. Spectrosc. Radiat. Transf.* 177, 177 (2016).
72. V.M. Devi, D.C Benner, K. Sung, L.R. Brown, T.J. Crawford, **S. Yu**, M.A.H. Smith, A.W. Mantz, V. Boudon and S. Ismail, "Spectral line parameters including line shapes in the  $2\nu_3$  Q branch of  $^{12}CH_4$ ", *J. Quant. Spectrosc. Radiat. Transf.* 177, 152 (2016).
71. **S. Yu**, J.C. Pearson, B.J. Drouin, T.J. Crawford, A.M. Daly, B. Elliott and T. Amano, "Rotational spectroscopy of vibrationally excited  $N_2H^+$  and  $N_2D^+$  up to 2.1 THz", *J. Mol. Spectrosc.* 314 (2015), 19.

70. V.M. Devi, D.C Benner, K. Sung, T.J. Crawford, **S. Yu**, L.R. Brown, M.A.H. Smith, A.W. Mantz, V. Boudon and S. Ismail, "Self- and Air-broadened line shapes in the  $2\nu_3$  P and R branches of  $^{12}\text{CH}_4$ ", *J. Mol. Spectrosc.* 315, 114 (2015).
69. C. Duan, M. Carvajal, **S.Yu**, J.C. Pearson, B.J. Drouin and I. Kleiner, "THz extended spectrum of the monodeuterated methyl formate ( $\text{DCOOCH}_3$ )", *Astron. & Astrophys.* 576 (2015), A39.
68. A. Daly, B.J. Drouin, P. Groner, **S. Yu**, J.C. Pearson, "Analysis of the rotational spectrum of the ground and first torsional states of monodeuterated ethane,  $\text{CH}_3\text{CH}_2\text{D}$ ", *J. Mol. Spectrosc.* 307 (2015) 27-32.
67. **S. Yu**, Brian J. Drouin and C. E. Miller, "High resolution spectral analysis of oxygen. IV. Energy levels, partition sums, band constants, RKR potentials, Franck-Condon factors involving the  $X^3\Sigma_g^-, a^1\Delta_g, b^1\Sigma_g^+$  states", *J. Chem. Phys.* 141 (2014) 174302.
66. J.L. Neill, E.A. Bergin, D.C. Lis, P. Schilke, N.R. Crockett, C. Favre, M. Emprechtinger, C. Comito, S.-L. Qin, D.E. Anderson, A.M. Burkhardt, J.-H. Chen, B.J. Harris, S.D. Lord, B.A. McGuire, T.D. McNeill, R.R. Monje, T.G. Phillips, A.L. Steber, T. Vasyunina and **S. Yu**, "Herschel observations of EXtraordinary Sources: Analysis of the full Herschel/HIFI molecular line survey of Sagittarius B2 (N)", *Astrophys. J.* 789 (2014), 8.
65. N.R. Crockett, E.A. Bergin, J.L. Neill, C. Favre, P. Schilke, D.C. Lis, T.A. Bell, G. Blake, J.Cernicharo, M. Emprechtinger, G.B. Esplugues, H. Gupta, M. Kleshcheva, S. Lord, N. Marcelino, B.A. McGuire, J. Pearson, T.G. Phillips, R. Plume, F.van der Tak, B. Tercero, and **S.Yu**, "Herschel observation of Extraordinary Sources: Analysis of the HIFI 1.2 THz wide spectral survey towards Orion KL. I. Methods", *Astrophys. J.* 787 (2014) ,112.
64. **S. Yu** and J.C. Pearson, "Terahertz measurements of the hot hydronium ion with an extended negative glow discharge", *Astrophys. J.* 786 (2014), 133.
63. D.C. Lis, P. Schilke, E. A. Bergin, M. Gerin, J.H. Black, C. Comito, M. De Luca, B. Godard, R. Higgins, F. Le Petit, J.C. Pearson, E. W. Pellegrini, T. G. Phillips, and **S. Yu**, "Widespread rotationally hot hydronium ion in the Galactic interstellar medium", *Astrophys. J.* 785 (2014), 135.
62. A.M. Daly, B.J. Drouin, **S. Yu**, "Submillimeter measurements of the Criegee intermediate  $\text{CH}_2\text{OO}$ , in the gas phase", *J. Mol. Spectrosc.* 297 (2014), 16-20.
61. R.A. Motiyenko, V.V. Ilyushin, B.J. Drouin, **S. Yu** and L. Margulès, "Rotational spectroscopy of methylamine up to 2.6 THz", *Astron. and Astrophys.* 563 (2014), A137.
60. B. J. Drouin, **S. Yu**, B.E. Elliott, T.J. Crawford and C. E. Miller, "High resolution spectral analysis of oxygen III. Laboratory investigation of the airglow bands", *J. Chem. Phys.* 139 (2013) 144301/1-144310/11.
59. B.J. Drouin, **S. Yu** and H. Gupta, "Characterization and use of a 1.3–1.5 THz multiplier chain for molecular spectroscopy", *IEEE Transaction on Terahertz Science and Technology* 3 (2013) 314-321.
58. **S. Yu**, J.C. Pearson and B.J. Drouin, "Terahertz spectroscopy of water in its second triad", *J. Mol. Spectrosc.* 288 (2013) 7-10.
57. C. M. Persson, M.DeLuca, B. Mookerjea, A.O.H.Olofsson, J.H.Black, M. Gerin, E.Herbst, T.A.Bell, A. Coutens, B. Godard, J. R. Goicoechea, G. E. Hassel, P. Hily-Blant, K.M. Menten, H.S.P.Müller, J. C. Pearson, and S.Yu, "Nitrogen hydrides in interstellar gas II. Analysis of Herschel/HIFI observations towards W49N and G10.6-0.4 (W31C)", *Astron. And Astrophys.* 543 (2012) A145.
56. Z. Kisiel, L. Pszczolkowski, B.J. Drouin, C.S. Brauer, **S. Yu**, J.C. Pearsonm I.R. Medvedev, S. Fortman and C. Neese, "Broadband rotational spectroscopy of acrylonitrile: Vibrational energies from perturbations", *J. Mol. Spectrosc.* 280 (2012) 134-144.

55. J.C. Pearson, **S. Yu** and B.J. Drouin, "The ground state torsion rotation spectrum of CH<sub>2</sub>DOH", *J. Mol. Spectrosc.* 280 (2012) 119-133.
54. **S. Yu**, J.C. Pearson, B.J. Drouin, M.-A. Martin-Drumel, O. Pirali, M. Vervloet, L.H. Coudert, H.S.P. Muller and S. Brunken, "Measurement and analysis of new terahertz and far-infrared spectra of high temperature water", *J. Mol. Spectrosc.* 279 (2012) 16-25.
53. B. J. Drouin, H. Gupta, **S. Yu**, C. E. Miller, and H.S.P. Muller, "High resolution spectral analysis of oxygen II. rotational spectra of  $a^1\Delta_g$  O<sub>2</sub> isotopologues", *J. Chem. Phys.* 137 (2012) 024305/1-024304/11.
52. **S. Yu**, C. E. Miller, B. J. Drouin and H.S.P. Muller, "High resolution spectral analysis of oxygen I. isotopically invariant dunham fit for the  $X^3\Sigma_g^-, a^1\Delta_g, b^1\Sigma_g^+$  states" *J. Chem. Phys.* 137 (2012) 024304/1-024304/20.
51. S. Wang, E. A. Bergin, N. R. Crockett, P. F. Goldsmith, D. C. Lis, J. C. Pearson, P. Schilke<sup>4</sup>, T. A. Bell, C. Comito, G. A. Blake, E. Caux, C. Ceccarelli, J. Cernicharo, F. Daniel, M.-L. Dubernet, M. Emprechtinger, P. Encrenaz, M. Gerin, T. F. Giesen, J. R. Goicoechea, H. Gupta, E. Herbst, C. Joblin, D. Johnstone, W. D. Langer, W. B. Latter, S. D. Lord, S. Maret, P. G. Martin, G. J. Melnick, K. M. Menten, P. Morris, H. S. P. Müller, J. A. Murphy, D. A. Neufeld, V. Ossenkopf, M. Pérault, T. G. Phillips, R. Plume, S.-L. Qin, S. Schlemmer, J. Stutzki, N. Trappe, F. F. S. van der Tak, C. Vastel, H. W. Yorke, **S. Yu** and J. Zmuidzinas, "Herschel observations of EXtra-Ordinary Sources (HEXOS): Methanol as a probe of physical conditions in Orion KL", *Astron. & Astrophys.* 527 (2011) A95.
50. B.J. Drouin and **S. Yu**, "Acetylene spectra near 2.6 THz", *J. Mol. Spectrosc.* 269 (2011), 254-256.
49. B.J. Drouin, **S. Yu**, J.C. Pearson and H. Gupta, "Terahertz spectroscopy for space applications: 2.5–2.7 THz spectra of HD, H<sub>2</sub>O and NH<sub>3</sub>", *J. Mol. Struct.* (2011), doi:10.1016/j.molstruc.2011.05.062.
48. J.C. Pearson, B.J. Drouin, **S. Yu**, and H. Gupta, "Microwave spectroscopy of methanol between 2.48 and 2.77 THz", *J. Opt. Soc. Am. B* 28 (2011), 2549-2577.
47. J.C. Pearson, B.J. Drouin, A. Maestrini, I. Mehdi, J. Ward, R.H. Lin, **S. Yu**, J.J. Gill, B. Thomas, C. Lee, G. Chattopadhyay, E. Schlecht, F.W. Maiwald, P.F. Goldsmith, and P. Siegel, "Demonstration of a room temperature 2.48–2.75 THz coherent spectroscopy source", *Rev. Sci. Instrum.* 82 (2011), 093105.
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