PETER GAO

http://www.gps.caltech.edu/~pgao | pgao@caltech.edu
NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035, USA | (626) 298 9098

EDUCATION

PhD, Planetary Sciences, California Institute of Technology **2016**
Thesis: Clouds and Hazes in Planetary Atmospheres

MS, Planetary Sciences, California Institute of Technology **2014**

BSc, Physics, University of British Columbia **2010**

RESEARCH EXPERIENCE

NASA Postdoctoral Program Fellow **NASA Ames** **2016 - Present**
- **Advisor**: Dr. Mark S. Marley
- Modelling clouds and hazes on exoplanets and Brown Dwarfs, with applications to ongoing and future missions and observing campaigns, such as WFIRST.

Graduate Research Assistant **Caltech** **2012 - 2016**
- **Advisors**: Prof. Yuk L. Yung and Prof. Heather A. Knutson
- Modelling the sulfuric acid clouds of Venus and the photochemical hazes of Titan and Pluto using the FORTRAN 90/95 1D microphysics and vertical transport code CARMA and plotting the results in IDL and Python.
- Extension of CARMA to simulating exoplanet clouds and hazes.
- Simulating the atmospheric chemistry of terrestrial exoplanets around M Dwarfs using a FORTRAN 77 1D chemical kinetics and transport code and plotting the results in Python.
- Analyzing Cassini ISS data of the Enceladus plumes to constrain its solid-to-vapor mass ratio from forward scattering of fractal aggregate ice particles.

Graduate Research Assistant **Caltech** **2011 - 2016**
- **Advisor**: Prof. Peter P. Plavchan
- Building a MATLAB and IDL data analysis pipeline for the processing of observed infrared stellar spectra into radial velocities to find exoplanets.
- Observing stellar targets using NASA IRTF's CSHELL.

Graduate Research Assistant **Caltech** **2010 - 2012**
- **Advisor**: Prof. David J. Stevenson
- Calculating moments of inertia of icy satellites due to internal nonhydrostatic anomalies.

NSERC Undergraduate Research Assistant **UBC** **2010**
- **Advisor**: Prof. Mark Halpern
- Designing a radio telescope antenna for the CHIME project using SolidWorks and Altium.

RESEARCH INTERESTS

Aerosols and chemistry in planetary atmospheres | Evolution of icy satellites' interiors | Precision radial velocity measurements for the detection of exoplanets

SKILLS

MATLAB | FORTRAN 90/95 | IDL | Python | Microsoft Office

TEACHING/MENTORING EXPERIENCE

Graduate Mentor **Caltech** **2015 - 2016**
- Advised 1st year graduate student

Teaching Assistant **Caltech** **2015**
- Professor: Yuk L. Yung
- Class: Planetary Habitability

Teaching Assistant **Caltech** **2014**
- Professor: Michael E. Brown
- Class: Introduction to the Solar System

Teaching Assistant **Caltech** **2012 - 2013**
- Professor: David J. Stevenson
- Class: Planetary Structure and Evolution

Alma Mater Society Tutor **UBC** **2009 - 2010**
- Tutored 1st and 2nd year Calculus

SCHOLARSHIPS & AWARDS

51 Pegasi b Fellowship	2016
NASA Postdoctoral Program Fellowship	2016
Kavli Summer Program in Astrophysics Fellowship	2016
AGU Outstanding Student Paper Award	2015
DPS Hartmann Travel Grant	2015
CESASC Scholarship	2015
AAS International Travel Grant	2015
NASA Astrobiology Institute Scholarship	2014
VEXAG 11 Student Travel Grant	2013
NSERC Undergraduate Student Research Award	2010
Dean of Science Scholarship	2009
Volkoff Scholarship in Science	2008
Trek Excellence Scholarship for Continuing Students	2007-2009
Thomas and Evelyn Hebb Memorial Scholarship	2007-2008
Charles and Jane Banks Scholarship	2007
British Columbia Government Scholarship	2005

PUBLICATIONS

[21] **Gao P.**, Marley M. S., Zahnle K., Robinson T. D., and Lewis N. K. (2016) Sulfur Hazes in Giant Exoplanet Atmospheres: Impacts on Reflected Light Spectra. *ApJ*. Submitted.

[20] Kite E. S., Goldblatt, C., **Gao P.**, and Mayer, D. P. (2016) Duration and Rapid Shutdown of Mars Lake-Forming Climates Explained by Methane Bursts. *Nature Geoscience*. Submitted.

[19] Kammer J. A., Shemansky D. E., Fan S., **Gao P.**, and Yung Y. L. (2016) Morphology and Properties of Titan's Atmospheric Aerosols. *Icarus*. Submitted.

[18] Wong M. L., Charnay B. D., **Gao P.**, Yung Y. L., and Russell M. J. (2016) Nitrogen Oxides in Early Earth's Atmosphere as Electron Acceptors for Life's Emergence. *Astrobiology*. Accepted.

[17] **Gao P.**, Fan S., Wong M. L., Liang M.-C., Shia R.-L., Kammer J. A., Yung Y. L., Summers M. E., Gladstone G. R., Young L. A., Olkin C. B., Ennico K., Weaver H. A., Stern S. A., and the New Horizons Science Team. (2016) Constraints on the Microphysics of Pluto's Photochemical Haze from New Horizons Observations. *Icarus*. Accepted.

[16] Wong M. L., Fan S., **Gao P.**, Liang M.-C., Shia R.-L., Yung Y. L., Kammer J. A., Summers M. E., Gladstone G. R., Young L. A., Olkin C. B., Ennico K., Weaver H. A., Stern S. A., and the New Horizons Science Team. (2016) The Photochemistry of Pluto's Atmosphere as Illuminated by New Horizons. *Icarus*. Accepted.

[15] Hu R., Bloom A., **Gao P.**, Miller C. E., and Yung Y. L. (2016) Hypotheses for Near-Surface

Exchange of Methane on Mars. *Astrobiology* **16**, 539

[14] **Gao P.**, Plavchan P. P., Gagné J., Furlan E., Bottom M., Anglada-Escudé G., White R. J., Davison C., Beichman C. A., Brinkworth C., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L. A., Kane S. R., Tanner A. M., Crawford T. J., Rougeot R., Geneser C. S., and Catanzarite J. (2016) Retrieval of Precise Radial Velocities from Near-Infrared High Resolution Spectra of Low Mass Stars. *PASP* **128**, 104501

[13] Gagné J., Plavchan P. P., **Gao P.**, Anglada-Escudé G., Furlan E., Davison C., Tanner A. M., Brinkworth C., Latham D., Bottom M., White R. J., Mills S., Beichman C. A., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L. A., Kane S. R., Mamajek E. E., Walp B., Crawford T. J., Rougeot R., Geneser C. S., and Catanzarite J. (2016) A Near-Infrared Survey for Radial Velocity Variable Low Mass Stars using CSHELL and a Methane Gas Cell. *ApJ* **822**, 40.

[12] Yi X., Vahala K., Li J., Diddams S., Ycas G., Plavchan P. P., Leifer S., Sandhu J., Vasisht G., Chen P., **Gao P.**, Gagné J., Furlan E., Bottom M., Martin E. C., Fitzgerald M. P., Doppmann G., and Beichman C. (2016) Demonstration of a Near-IR Line-Referenced Electro-Optical Laser Comb for Precision Radial Velocity Measurements in Astronomy. *Nat. Commun.* **7**, 10436

[11] **Gao P.**, Kopparla P., Zhang X., and Ingersoll A. P. (2016) Aggregate Particles in the Plumes of Enceladus. *Icarus* **264**, 227

[10] Plavchan P. P., **Gao P.**, Gagné J., Furlan E., Brinkworth C., Bottom M., Tanner A. M., Anglada-Escudé G., White R. J., Davison C., Mills S., Beichman C. A., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., Vasisht G., Prato L. A., Kane S. R., Crawford S., Crawford T., Sung K., Drouin B., Lin S., Leifer S., Catanzarite J., Henry T., von Braun K., Walp B., Geneser G., Ogden N., Stufflebeam A., Pohl G., and Regan J. (2015) Precise Near-Infrared Radial Velocities. Young Stars & Planets Near the Sun Proceedings, IAU Symposium 314.

[9] **Gao P.**, Hu R., Robinson T. D., Cheng L., and Yung Y. L. (2015) Stabilization of CO_2 Atmospheres on Desiccated M Dwarf Exoplanets. *ApJ* **806**, 249

[8] Cheng L., Zhang X., **Gao P.**, and Yung Y. L. (2015) Vertical Distribution of C_3 Hydrocarbons in the Stratosphere of Titan. *ApJL* **803**, L19

[7] Parkinson C. D., **Gao P.**, Esposito L., Yung Y. L., Bougher S. W., and Hirtzig M. (2015) Photochemical Control of the Distribution of Venusian Water. *PSS* **113**, 226

[6] Parkinson C. D., **Gao P.**, Schulte R., Bougher S. W., Yung Y. L., Bardeen C. G., Wilquet V., Vandaele A. C., Mahieux A., Tellmann S., and Pätzold M. (2015) Distribution of Sulphuric Acid Aerosols in the Clouds and Upper Haze of Venus Using Venus Express VAST and VeRa Temperature Profiles. *PSS* **113**, 205

[5] **Gao P.**, Zhang X., Crisp D., Bardeen C. G., and Yung Y. L. (2014) Bimodal Distribution of Sulfuric Acid Aerosols in the Upper Haze of Venus. *Icarus* **231**, 83

[4] Plavchan P. P., Bottom M., **Gao P.**, Wallace J. K., Mennesson B., Ciardi D., Crawford S., Lin S., Beichman C., Brinkworth C., Johnson J. A., Davison C., White R., Anglada-Escude G., von Braun K., Vasisht G., Prato L., Kane S., Tanner A., Walp B., and Mills S. (2013) Precision near-infrared radial velocity instrumentation II: Non-Circular Core Fiber Scrambler. *SPIE* **8864**, 0G

[3] Plavchan P. P., Anglada-Escude G., White R., **Gao P.**, Davison C., Mills S., Beichman C., Brinkworth C., Johnson J. A., Bottom M., Ciardi D., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L., Kane S., Tanner A., Walp B., Crawford S., and Lin S. (2013) Precision near-infrared radial velocity instrumentation I: Absorption Gas Cells. *SPIE* **8864**, 1J

[2] **Gao P.** and Stevenson D. J. (2013) Nonhydrostatic Effects and the Determination of Icy Satellites' Moment of Inertia. *Icarus* **226**, 1185

[1] Anglada-Escudé G., Plavchan P., Mills S., **Gao P.**, García-Berríos E., Lewis N. S., Sung K., Ciardi D., Beichman C., Brinkworth C., Johnson J., Davison C., White R., and Prato L. (2012) Design and Construction of Absorption Cells for Precision Radial Velocities in the K Band Using Methane Isotopologues. *PASP* **124**, 586

CONFERENCES/WORKSHOPS/INVITED TALKS

Gao P., Marley M. S., Zahnle K., Robinson T. D., and Lewis N. K. (2017) Impacts of Sulfur Hazes on the Reflected Light Spectra of Giant Exoplanets. *AAS 229*, **202.03**, Grapevine, USA

Gao P., Carlson R. W., Robinson T. D., Crisp D., Lyons J. R., and Yung, Y. L. (2016) Microphysics of KCl and ZnS Clouds in the Atmosphere of GJ 1214 b. *AGU Fall Meeting 2016*, **P53B-2201**, San Francisco, USA

Gao P. (2016) Clouds and Hazes in Exoplanet Atmospheres, University of California Berkeley, Berkeley, USA (**Invited**)

Gao P. and Benneke, B. (2016) Microphysics of KCl and ZnS Clouds in the Atmosphere of GJ 1214 b. *DPS 48/EPSC 11*, **302.02**, Pasadena, USA

Gao P. and Benneke, B. (2016) Microphysics of KCl and ZnS Clouds in the Atmosphere of GJ 1214 b. *ExoClimes III*, Squamish, Canada

Gao P., Marley, M. S., Zahnle, K., and Robinson, T. D. (2016) Sulfur Hazes in Giant Exoplanet Atmospheres: Impacts on Reflected Light Spectra. Kavli Summer Program in Astrophysics 2016, Santa Cruz, USA

Gao P. (2016) Clouds and Hazes in Planetary Atmospheres. University of Chicago, Chicago, USA (**Invited**)

Gao P., Benneke B., Knutson H. A., and Yung Y. L. (2016) Microphysics of Exoplanet Clouds and Hazes. *AAS 227,* **112.04D**, Kissimmee, USA

Gao P., Kopparla P., Zhang X., and Ingersoll A. P. (2015) Frozen Fractals All Around: Aggregate Particles in the Plumes of Enceladus. *AGU Fall Meeting 2015*, **P11D-08**, San Francisco, USA (**Winner of an *Outstanding Student Paper Award***)

Gao P., Benneke B., Knutson H. A., and Yung Y. L. (2015) Microphysics of Exoplanet Clouds and Hazes. *Extreme Solar Systems III,* **111.07**, Waikoloa, USA

Gao P., Benneke B., Knutson H. A., and Yung Y. L. (2015) Microphysics of Exoplanet Clouds and Hazes. *DPS 47,* **504.04D**, National Harbor, USA

Gao P., Hu R., Robinson T. D., Cheng L., and Yung Y. L. (2015) Stability of CO_2 Atmospheres on Dry M Dwarf Exoplanets. *ExSoCal 2015*, Pasadena, USA

Gao P. (2015) Atmospheric Chemistry of Planets Around M Dwarfs. *Pathways 2015: Pathways Towards Habitable Planets, Satellite Meeting 4*, Bern, Switzerland. **(Invited)**

Gao P., Hu R., Robinson T. D., Cheng L., and Yung Y. L. (2015) Stability of CO_2 Atmospheres on Desiccated M Dwarf Exoplanets. *Pathways 2015: Pathways Towards Habitable Planets, General Meeting*, **63429**, Bern, Switzerland.

Gao P., Plavchan P. P., Gagné J., Furlan E., Bottom M., Anglada-Escudé G., White R. J., Davison C., Mills S., Beichman C. A., Brinkworth C., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L. A., Kane S. R., Tanner A. M., Walp B., Crawford S., Lin S., Crawford T., Sung K., Drouin B., Leifer S., Catanzarite J., Henry T., Geneser C., Ogden N., Stufflebeam A., Pohl G., and Regan J. (2015) Retrieval of Precise Radial Velocities from M Dwarfs in the Near-IR. Johnson ExoLab, Harvard University, Cambridge, USA. **(Invited)**

Gao P., Plavchan P. P., Gagné J., Furlan E., Bottom M., Anglada-Escudé G., White R. J., Davison

C., Mills S., Beichman C. A., Brinkworth C., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L. A., Kane S. R., Tanner A. M., Walp B., Crawford S., and Lin S. (2015) Retrieval of Precise Radial Velocities from M Dwarfs in the Near-IR. *Extreme Precision Radial Velocities II*, New Haven, USA.

Gao P., Plavchan P. P., Gagné J., Furlan E., Bottom M., Anglada-Escudé G., White R. J., Davison C., Mills S., Beichman C. A., Brinkworth C., Johnson J. A., Ciardi D. R., Wallace J. K., Mennesson B., von Braun K., Vasisht G., Prato L. A., Kane S. R., Tanner A. M., Walp B., Crawford S., and Lin S. (2015) Retrieval of Precise Radial Velocities from High Resolution Near-Infrared Spectra of M Dwarfs. *AAS 225*, **258.22**, Seattle, USA.

Gao P., Parkinson C. D., Bardeen C. G., and Yung Y. L. (2014) Venus Then and Now: Simulating Sulfuric Acid Clouds Using Latitudinally Dependent VIRA and VeRA Temperature Profiles. *AGU Fall Meeting 2014*, **P53C-4029**, San Francisco, USA.

Gao P., Hu R., Robinson T. D., Cheng L., and Yung Y. L. (2014) The Role of Hydrogen in Determining the Stability of CO_2 Atmospheres of Terrestrial Exoplanets Around M Dwarfs. *DPS 46*, **301.01**, Tucson, USA.

Gao P., O'Rourke J., Brissaud Q., Blom C., and Lorenz R. (2014) Active Sources for Venus Seismology, KISS Venus Seismology Workshop, Pasadena, USA

Gao P., Hu R., and Yung Y. L. (2013) Stability of CO_2 Atmospheres on Terrestrial Exoplanets in the Proximity of M Dwarfs. *AGU Fall Meeting 2013*, **P21B-1728**, San Francisco, USA.

Gao P., Zhang X., Crisp D., Bardeen C. G., and Yung Y. L. (2013) Modelling the Venus Clouds and Upper Haze using CARMA 3.0. Venus Exploration Analysis Group Meeting 11, Washington DC, USA.

Gao P., Zhang X., Crisp D., Bardeen C. G., and Yung Y. L. (2013) Bimodal Distribution of Sulfuric Acid Aerosols in the Atmosphere of Venus. *DPS 45*, **118.07**, Denver, USA.

Gao P., Zhang X., Crisp D., Bardeen C. G., and Yung Y. L. (2012) Meteoric Dust as Condensation Nuclei of Small-Mode Particles in the Upper Haze of Venus. *AGU Fall Meeting 2012*, **P11D-1850**, San Francisco, USA.

Gao P. and Stevenson D. J. (2012) The Effect of Nonhydrostatic Features on the Interpretation of Mercury's Mantle Density from MESSENGER Results. *DPS 44*, **401.08**, Reno, USA.

Gao P. and Stevenson D. J. (2012) How Does Nonhydrostaticity Affect the Determination of Titan's Moment of Inertia? Titan Geophysics Workshop, Caltech, Pasadena, USA.

Gao P. and Stevenson D. J. (2012) How Does Nonhydrostaticity Affect the Determination of Icy Satelltes' Moment of Inertia? CPS 9th International School of Planetary Sciences: Across the Earth into Exoplanets, Kobe, Japan.

Gao P. and Stevenson D. J. (2012) How Does Nonhydrostaticity Affect the Determination of Icy Satellites' Moment of Inertia? *LPSC 43*, **1701**, The Woodlands, USA.

Gao P., Zhang X., Crisp D., Bardeen C. G., and Yung Y. L. (2012) Bimodal Distribution of H2SO4 Aerosols in the Upper Atmosphere of Venus. *LPSC 43*, **2906**, The Woodlands, USA.