# Ravi kumar Kopparapu

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http://www3.geosc.psu.edu/~ruk15/

## EDUCATION

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|---|---|
| 2006 | Ph.D. (Physics), Louisiana State University (LSU), Baton Rouge, LA |
| 2003 | M.S. (Physics), Louisiana State University (LSU), Baton Rouge, LA |
| 1998 | M.Sc. (Physic), University of Pune, Pune, India |
| 1996 | B.Sc. (Electronics), Nagarjuna University, India |

## PROFESSIONAL EXPERIENCE

9/2015 – Present: Assistant Research Scientist, University of Maryland/NASA Goddard Space Flight Center
9/2013 – 08/2015: Research Associate, Planetary Science, Pennsylvania State University (Penn State)
9/2010 – 8/2013: Postdoctoral Scholar, NASA Astrobiology Institute's Virtual Planetary Lab, Penn State
9/2007 – 8/2010: Postdoctoral Scholar, Center for Gravitational-Wave Astronomy, Penn State
1/2007 – 7/2007: Postdoctoral Scholar, Center for Computation and Technology, LSU

## RESEARCH INTERESTS

Extrasolar planets: habitability, atmospheric modeling and characterization, planetary transit and statistical analysis.

## KEY SCIENCE RESULTS

- Determined habitable zone (HZ) estimates for different stars using climate models
- *All* the currently known exoplanets discovered in the HZs around other stars, to-date, have used the HZ estimates from my work
- HZ results used as one of the standards for defining habitable planets for NASA concept missions: LUVOIR, HabEX

## INVOLVEMENT IN MAJOR INITIATIVES

- Chair, LUVOIR seminar series
- NASA LUVOIR Science Analysis Team
- NASA Origins Space Telescope (OST) Science working group
- NASA Exoplanet Program Analysis Group (ExoPAG) SAG-13, SAG-15 member
- Nexus for Exoplanet System Science (NEXSS) ROCKE-3D Committee
- LOC member for NEXSS "*Habitable Worlds 2017*" conference

**PUBLICATION METRICS**

- First to third author papers: 27 (average citation: 43)
- $N^{th}$ author papers: 59 (average citation: 39)
- h-index: 47 (Source: Google Scholar)

## REVIEWER

- Science
- Nature
- Astrophysical Journal
- Astrophysical Journal Letters
- Astronomy & Astrophysics
- Astronomical Journal
- Astronomy and Space Physics
- Monthly Notices of Royal Astronomical Society (MNRAS)
- Astrobiology
- International Journal of Astrobiology
- Journal of Geophysical Research
- Planetary and Space Science
- Earth, Moon and Planets
- *Comparative Climatology on Terrestrial Planets,* Book review (Space Science series)
- NASA *Kepler* Participating Scientist Program review panel
- NASA Exoplanet Exploration Program review panel
- NASA Emerging Worlds Program review panel
- NASA Solar System Workings panel
- NASA WFIRST-AFTA Science Investigation Team
- NASA Hubble Fellowship review panel

## BOOKS AND CHAPTERS

- Chapter on "Time-dependent Drake equation". *Habitability of the Universe Before Earth*: Astrobiology: Exploring Life on Earth and Beyond. Amsterdam, Elsevier B.V., 2017
- Chapter on "The Habitable Zone: The Climatic Limits of Habitability". *Handbook of Exoplanets*, edited by Juan Antonio Belmonte & Hans J. Deeg, Springer Publishers (In Press)
- Chapter on "Factors Affecting Planetary Habitability", *Planetary Astrobiology*, Space Science Series (2019)
- AAS-IOP Publishing contract to write a book on "Habitable Zones and Habitability of Planets" (In Process)

## CURRENT FUNDING & GRANTS:

- Determining the inner edge of the habitable zone for M-dwarf stars using 3-D GCMs, **PI**, NASA Habitable Worlds program (2015), $442,000 (12/01/2015-11/30/2017)
- Virtual Planetary Laboratory (VPL)-NASA Astrobiology Institute, (11/01/2012 – 10/31/2017)
- Organic Habitable Worlds: Simulating Habitable Zones for Organic-Rich Atmospheres, **Co-I,** NASA Habitable Worlds program (2016). PI, Shawn Domagal-Goldman, NASA-GSFC (08/01/2016 – 07/31/2019)

- Constraining the Habitable Zones of Binary Star Systems (2018-2020), **Co-I**, NASA Habitable Worlds Program.

## SUBMITTED PROPOSALS

- Habitable Moist-Greenhouse Atmospheres On Terrestrial Planets Around M-Dwarfs, **PI,** NASA Habitable Worlds program (2017), $520,000 (12/01/2017 – 11/30/2019)
- Comprehensive 3D Atmosphere Modeling of Proxima Centauri b, **Co-I**, NASA Habitable Worlds program (2017). $222, 632 (10/01/2017 – 09/30/2020)
- Observing the ExoEarth: Retrieving Rotation, Albedo, and Obliquity, **Collaborator,** NASA Habitable Worlds program (2016). PI, Stephen Kane, San Francisco State University (**Submitted**)

## INVITED SCIENTIFIC TALKS

- Space Telescope Science Institute, 2017
- Carnegie Institute of Washington, DTM, 2016
- The Astrophysics of Planetary Habitability, Vienna, Austria, 2016
- NASA Goddard Space Flight Center, 2015
- Louisiana State University, Department of Astronomy, 2015
- University of Zurich, Bern, 2015
- Session co-chair, "Pathways Towards Habitable Worlds", Bern, 2015
- Max Planck Institute for Astronomy, Germany, 2014
- Session Chair, "Habitable Worlds Across Time and Space," STScI, 2014
- Inter University Center for Astronomy & Astrophysics, India, 2014
- NASA Exoplanet Science Institute (NExScI, CalTech), 2014
- Department of Earth, Planetary and Space Sciences, UCLA, 2014
- Jet Propulsion Laboratory, NASA, 2014
- Yale University, Department of Astronomy, 2014
- Exoplanets and Disks workshop, Kona, Hawaii, 2013
- NASA ExoPAG meeting, Denver, Colorado, 2013
- John Hopkins University Astrobiology Colloquium, 2013
- Arizona State University, Workshop Without Walls, 2013
- NASA Goddard Space Flight Center, Exoplanets seminar, 2011
- NASA Astrobiology Institute workshop on Revisiting the Habitable Zone, Seattle, 2010
- Center for Exoplanets and Habitable Worlds, Penn State, 2010
- NASA Goddard Space Flight Center, Exoplanets seminar, 2010
- Northwestern University, special colloquium, 2010
- Northwestern University, theoretical astrophysics group, 2010
- Penn State Institute for Gravitation and Cosmos post-grad seminar, 2010

## INVITED PUBLIC TALKS

- University of Maryland Observatory, 2015
- Friedman public lecture in Astrophysics, Penn State, 2014

- Director, Science-U summer camp 'Alien AstronoMysteries,' Penn State, 2014
- Invited speaker at schools (2000 students), Vijayawada, India, 2014
- Planetarium co-ordinator, Department of Astronomy, Penn State, 2013
- Invited speaker at summer teacher's workshop, Penn State, 2013
- Invited speaker for road scholar program, 2013
- Invited speaker Mount Nittany Elementary School, State College, PA, 2013
- Online student educator: 'I am a Scientist, Get me out of here', United Kingdom, 2013
- Invited speaker at elementary schools, State College, PA, 2012
- Invited featured talk "Habitable Worlds in our Galaxy," Blue Marble Space Institute, 2012
- Featured talk: "Alien probes in our Solar System," Penn State, 2012
- Public talks & lectures at various high schools in India, 2012
- Featured public talk on habitable planets at the annual "Astrofest," Penn State, 2011.
- Coordinator for the telescope observation, Department of Astronomy, Penn State, 2011
- Directed rocket experiment at the annual Astrofest, Penn State, 2011
- "Science Day" guest speaker at Park Forest Elementary School, State College, PA, 2011
- Science exploration day volunteer at Penn State, 2010.
- Planetarium show at AstroFest 2010, Penn State, 2010
- Featured talk: "What makes a planet habitable," Astrofest, Penn State, 2010
- Co-creator of a program, based on "Black-hole Hunter" game for Astrofest, Penn State, 2009
- Public talk on total solar eclipse of July 22, 2009 at Science Center, Vijayawada,India, 2009
- Volunteer/Coordinator for astronomy on "Science Exploration Day," Penn State, 2009
- Volunteer/co-ordinator for public observing nights, Department of Astronomy, Penn State, 2008
- Organized public observing nights, Department of Physics and Astronomy, LSU, 2007

## TEACHING & MENTORING

- 2015-: Co-Mentoring a graduate student from U. Maryland College Park (Mahmuda Afrin Badhan)
- 2013-2014: Mentored two undergraduate students, Penn State (James Schottlekotte –Graduated in 2014, Jamie Vanderheiden-Graduated in 2014)
- 2013 Fall: Instructor, Introductory Astronomy class, Department of Astronomy, Penn State
- 2012 Fall: Instructor, Introductory Astronomy class, Department of Astronomy, Penn State
- 2012 Spring: Substitute Instructor for 'Planetary Atmospheres' class (senior undergraduate and graduate students), Penn State
- 2011: Substitute Instructor, Extra-solar Planets, Department of Geosciences, Penn State
- 2011: Lecturer on gravitational-waves for Physics 444 class, Penn State
- 2011: Instructor, senior undergraduate class on General Theory of Relativity at Penn State
- 2008-2010: Mentored an undergraduate student on a research project related to the sensitivity of LISA spacecraft to gravitational-waves, Penn State *(Karan Jani, graduated in 2011. Karan is currently a graduate student at Georgia Tech, and played a key role in the recent discovery of gravitational-waves)*
- 2006-2007: Substitute Instructor, Introductory Astronomy course, LSU

## MEDIA COVERAGE

- NBC News
- CBS News
- NHK TV
- New York Times

- Newsweek
- Scientific American
- Smithsonian Air and Space Magazine
- New Scientist Magazine
- Popular Mechanics
- Science Daily
- Physics World
- Huffington Post
- Los Angeles Times
- Daily Mail
- Wikipedia article on 'Habitable Zones'
- Universe Today
- Centauri Dreams
- The Verge

**SCIENTIFIC PUBLICATIONS**

1. Habitable Moist Atmospheres on Terrestrial Planets near the Inner Edge of the Habitable Zone around M Dwarfs
   -**Kopparapu, R. K**., Wolf, E. T., Arney, G., Batalha, N. E., Haqq-Misra, J., Grimm, S., Heng, K, Astrophysical Journal, 845, 5 (2017)

2. Constraints on Climate and Habitability for Earth-like Exoplanets Determined from a General Circulation Model
   -Wolf, E. T., Shields, A. L., **Kopparapu, R. K**., Haqq-Misra, J., Toon, B. Astrophysical Journal, 837, 107, (2017)

3. A Catalog of Kepler Habitable Zone Exoplanet Candidates
   -Kane, S., Hill, M., Kasting, J. F., **Kopparapu, R. K.,** et al., Astrophysical Journal, 830, 1, arxiv: 1608:00620 (2016)

4. Limit Cycles Can Reduce the Width of the Habitable Zone
   -Haqq-Misra, J., **Kopparapu, R. K**., Batalha, N. E., Harman, C., Kasting, J. F., Astrophysical Journal, 827, 2, arxiv: 1605.07130 (2016)

5. The Inner Edge of the Habitable Zone for Synchronously Rotating Planets Around Low-mass Stars Using General Circulation Models
   -**Kopparapu, R. K.**, Wolf, Eric, Haqq-Misra, J. et al., Astrophysical Journal, 819, 84 (2016)

6. Climate Cycling and Valley Formation on Early Mars
   -Batalha, N., **Kopparapu, R. K**., Haqq-Misra, J., Kasting, Earth and Planetary Science Letters, 455, 7-13 (2016)

7. The Need for Laboratory Work to Aid in The Understanding of Exoplanetary Atmospheres
   -Fortney, J., et al., arxiv: 1602.06305

8. Stratospheric temperatures and water loss from moist greenhouse atmospheres of Earth-like planets
   -Kasting, J. F.; Chen, H.; **Kopparapu, R. K**., Astrophysical Journal Letters, (2015), Astrophysical Journal Letters, (2015), 813, L3

9. Geothermal Heating Enhances Atmospheric Asymmetries On Synchronously Rotating Planets
Haqq-Misra, J.; **Kopparapu, R. K**. MNRAS (2015)

10. On The Frequency Of Potential Venus Analogs From *Kepler* Data
-Kane, S. R.; **Kopparapu, R. K**., Domagal-Goldman, S. Astrophysical Journal Letters, (2014)

11. Can Increased Atmospheric $CO_2$ Levels Trigger a Runaway Greenhouse?
-Ramirez, R., **Kopparapu, R. K.,** Linder, V., Kasting, J. F. Astrobiology (2014)

12. Warming Early Mars with $CO_2$ and $H_2$
-Ramirez, R.; **Kopparapu, R**; Kasting, J. F.; Herman, C.; Zugger, M.; Robinson, T.; Freedman, R.; 2014, Nature Geoscience, 7, 59, (2014)

13. Stellar Stoichometry
-Young, P, A., Desch, S. J., Barnes, R., Hinkel, N. R., **Kopparapu R. K.,** Madhusudhan, N, et al. Astrobiology (2014)

14. Habitable Zones Around Main-Sequence Stars: Dependence on Planetary Mass.
-**Kopparapu, R**.; Ramirez,R.; SchottleKotte, J.; Kasting, J. F. 2014. Astrophysical Journal Letters, 787, L29 (2014)

15. Remote Life Detection Criteria, Habitable Zone Boundaries, and the Frequency of Earth-like Planets around M and Late-K Stars.
-Kasting, J. F.; **Kopparapu, R. K**.; Ramirez, R.; Harman, C. 2013, Proceedings of the National Academy of Sciences (PNAS), (2014).

16. A Revised Estimate of the Occurrence Rate of Terrestrial Planets in the Habitable Zones Around Kepler M-dwarfs.
-**Kopparapu, R**, Astrophysical Journal Letters, 767, 8 (2013)

17. Habitable zones around Main-Sequence stars: New Estimates.
-**Kopparapu, R**; Ramses R.; Kasting, J. F.; Eymet, V.; Robinson, T.;Meadows, V.; Domagal-Goldman, S.; Mahadevan, S.; Terrien, R.; Deshpande, R. Astrophysical Journal, 765, 131 (2013)

18. Secular Behavior of Exoplanets: Self-Consistency and Comparisons with the Planet-Planet Scattering Hypothesis.
-Timpe, M.; Barnes, R.; **Kopparapu, R**., Greenberg, R.; Raymond, S.; Gorelick, N. Astronomical Journal (2013)

19. A Photochemical Model for the Carbon Rich Planet Wasp-12b
-**Kopparapu, R**; Kasting, J. F.; Zahnle, K. , Astrophysical Journal, 745, Issue 1 (2012)

20. On the Likelihood of Non-terrestrial Artifacts in the Solar System
-Haqq-Misra, J; Kopparapu**, R**., ActaAstronautica (2012)

21. Population synthesis of hot subdwarfs

-Clausen, D.; Wade, R.; **Kopparapu, R**; O'Shaughnessy, R.; Astrophysical Journal, 746, 2 (2012)

22. Impact of star formation inhomogeneities on merger rates and interpretation of LIGO results
    -O'Shaughnessy, R.; **Kopparapu, R**.; Belczynski, K.; Classical Quantum Gravity, 29, 145011, (2012)

23. Stability analysis of single planet systems and their habitable zones
    -**Kopparapu, R**; Barnes, R; Astrophysical Journal, 716, 1336 (2010)

24. Population boundaries for compact white-dwarf binaries in LISA's amplitude-frequency domain
    -**Kopparapu, R**; Astrophysical Journal, 697, 2089 (2009)

25. Stability of Additional Planets in and Around the Habitable Zone of the HD 47186 Planetary System
    -**Kopparapu, R**; Raymond, S. N; Barnes, R; Astrophysical Journal letters, 695, 181 (2009)

26. Host Galaxies Catalog Used in LIGO Searches for Compact Binary Coalescence Events
    -**Kopparapu, R**; Hanna, C; Kalogera, V; O'Shaughnessy, R; Gonzalez, G; Brady, P. R; Fairhurst,S;, Astrophysical Journal, 675, 1459 (2008)

27. Population Boundaries for Galactic White Dwarf Binaries in LISA's Amplitude-Frequency Domain
    -**Kopparapu, R**; Tohline, J. E; Astrophysical Journal, 655, 1025 (2007)

The publications list does not include the 59 refereed publications; on which I was a co-author as a member of the LIGO Scientific Collaboration. These omitted publications (Abadie et al.; Abbott et al.; Baggio et al.; LIGO Scientific Collaboration et al.) spanned 2007-2012 and were included in the following journals: Physical Review D, Classical and Quantum Gravity, Astrophysical Journal, Physical Review Letters, New Journal of Physics, Reports on Progress in Physics, Nature, Nuclear Instruments and Methods in Physics Research Section A, Nature Physics, Astronomy & Astrophysics.