nature
Awards for Mentoring in Science

US West Coast: 2016
Nominee form

I. Important instructions

1. About this form:

1. This form is to be completed by the nominee.
2. Please provide a **one page CV**, listing your employment history and positions of responsibility (within and outside employers' institutions).
3. Please edit this Word document and submit it as an email attachment as part of your nomination package.
4. Responses must be in English.

2. A complete nomination package must:

1. Be collated and sent by email to mentor@nature.com as one complete nomination package.
2. Include a Nomination package form
3. Include completed Nomination forms from **five people**:
    - All of whom must have been mentored by the candidate at different times.
    - Each nominator must complete a separate form.
4. Include a copy of the Nominee form and accompanying CV **of maximum length one page**.
5. Be received by Monday 8 August 2016.

Forms can be found at: www.nature.com/nature/mentoringawards/uswestcoast/

II. Contact details for nominee

1. Your details

Name:	S. R. Kulkarni
Job title:	Professor of Astronomy & Planetary Science
Affiliation:	California Institute of Technology
e-mail:	srk@astro.caltech.edu
Phone:	+1 626 395 3734

III. Details of your nomination

1. Your scientific achievements

Please provide a brief summary (e.g. 300 words) of your scientific achievements, with up to four key career highlights or publications.

It is my deep conviction that all phenomena in nature are interesting. The key to appreciate Nature is to discover phenomena. For this reason I list my best four discoveries: the first millisecond pulsar, the first brown dwarf, the discovery that gamma-ray bursts (GRB) are of extra-galactic origin and the finding that long duration gamma-ray bursts are associated with deaths of massive stars. My thesis work served as the standard review of the state of diffuse neutral medium in our Galaxy.

My work provided evidence along multiple lines (energetics, inferring the size of radio afterglows via scintillation and afterglow light curves) that GRBs are "jetted" relativistic explosions. Pleiades ("Seven sisters") is an important laboratory to compare stellar astronomy models with the skies. Using a newly commissioned spatial infra-red interferometer we obtained an accurate and precise distance to Pleiades and challenged the claims of a smaller distance by HIPPARCOS, a major European astrometric mission. Subsequent observations showed we were correct.

Discovery requires an open mind, curiosity, powerful tools and wide knowledge. The majority of thesis projects of my students are centered on technique development. The Palomar Transient Factory incorporated many innovations and resulted in a cornucopia of discoveries in the field of supernovae and cosmological explosions. Some of the interesting discoveries have resulted from logical analysis of facts: the demonstration that magnetic fields of neutron stars do not decay (by noting that the companion of a pulsar was an cold and therefore an old white dwarf).

Recognizing a discovery usually requires deep theoretical understanding. I have made a point of working with theorists (tens of papers) and written or participated meaningfully in a few theory papers (electrodynamics of highly magnetized neutron stars; the possibility of free neutron decay as giving rise to early blue emission from the coalescence of neutron stars).

1. *Discovery of the first millisecond pulsar*, Nature 300, 615 (1982)
2. *Discovery of a cool brown dwarf*, Nature 378, 463 (1995)
3. *Spectral constraints on the redshift of the optical counterpart to the gamma-ray burst of 8 May 1997*, Nature 387, 878 (1997)
4. *The gamma-ray burst of GRB 980425 and its association with the extraordinary radio emission from a most unusual supernovae*, Nature 395, 663 (1998)

2. Your achievements in mentoring

Please describe in up to 700 words your achievements in mentoring and fostering scientific creativity.

I have advised or co-advised 28 students and mentored 38 postdoctoral fellows. Looking back I would say that the key to good mentoring distills to the following formula: structure the project so that the student builds up confidence -- preferably almost due to their own actions. On the occasion of my 50th paper in Nature, I was interviewed specifically about mentoring and creativity. The interview (Nature 437, xiii; 6 October 2005) is a succinct summary of the topic under consideration (see attachment). My mentoring framework has four elements (below student includes post-doctoral fellow in most instances):

I. Define A Clear & Transparent Framework. A key step in good mentoring is to choose mentees wisely. It is my view that not all students can work with all advisors. I inform inquiring students that I am looking for independent and self motivated students. I insist on a specific arrangement: at the end of the first year, either party can walk away.

II. Project assignment. I give students the option to define their thesis project. This approach has the student fully invested. I trace the success of at least half of my students to this approach (e.g. Rand, Bloom, Soderberg, Wictorowicz, Busch, Wasczak, Mooley).

III. Assign Project with Clear Expectations. Once a project is decided the student is given full responsibility for the project and maximal resources. I make it clear that the student has to organize appropriate review meetings (which I am happy to attend). This approach empowers the student and all my students have risen to the occasion. Once I won 120 Hubble telescope orbits (a substantial win). I entrusted the planning, the choice of targets and execution to graduate student Josh Bloom. The project was successful in the short term (great science) and long term (Josh is now Professor at UCB).

IV. Credit. I have a simple rule: first author belongs to those whose integral contribution is the largest. In practice this means that my students and postdocs become first author. Nothing inspires young people like a fair supervisor. I make this statement based on first hand experience.

Several times, owing to my longer experience, I was able to see or discern that a discovery was already present in our data. I made a point to let the student make the discovery on his or her own timescales, sometimes many months later. There is some risk of being scooped but in my view there is nothing more thrilling than making a discovery. In one particular case, a student figured out that this was the case but nonetheless thanked me for giving him the opportunity for discovery by self.

V. Post-parting arrangement. I have made it a point not to work in a field in which the student (in particular; less so with postdocs) did his or her thesis. This "sacrifice" is my ultimate gift to the student. This arrangement means that the student and advisor are not competitors the day after the PhD exam! At the same time I am known for saying "A mark of excellence is that a scientist walks away from his or her

thesis as soon as the ink is dry". Indeed, my best students have not taken advantage of my offer and gone off and pursued new ventures.

VI. Postdoctoral Fellows. I have developed (by now a proven) model of hiring fresh PhDs and entrusting them with major responsibilities. The practice started with the Palomar Transient Factory (a project aimed at a systematic study of the dynamical night sky), which at the time it was planned had many innovations: an integrated system of telescopes, Machine Learning replacing humans in recognizing genuine transients, robotic operations and fully automated robust and rapid pipelines. Nick Law as appointed as Project Scientist, Robert Quimby placed in charge of Software integration and Eran Ofek led the overall planning for automated observations and photometric calibration. The project went from thought to first light in 26 months -- a record. The same approach was duplicated for Robo-AO (PI: Chris Baranec) and SEDM (PI: Nick Konidaris). All those who graduated from this program have done remarkably well (Law, Baranec, Ofek and Quimby in academia; Konidaris to start-up).

3. Those you have mentored and their scientific achievements

Please identify some or all of those who have emerged from your lab(s) and indicate in just a few sentences any notable achievements. Please provide approximate dates of their time with you.

I have advised or co-advised 28 students and mentored 39 postdoctoral fellows. The list can be found at
http://www.astro.caltech.edu/~srk/former-stud-pd.html

Students:

1. Nakajima, Tadashi (PhD 1989; co-advised with G. Neugebauer). "Diffraction-Limted Imaging on the 200-inch Telescope". Worked on non-optical redundant masking for PhD. Discovered first brown dwarf as post-doctoral fellow. *Winner of Hayashi Prize*. Now staff member at the National Astronomical Observatory of Japan.

2. Rand, Richard (PhD 1991). "The Relationship Between the Density Wave, Molecular Gas and Star Formation in M51". Worked on distribution of warm ionized medium in our and other galaxies for PhD. Now professor of astronomy at the University of New Mexico, Albuquerque.
3. Johnston, Helen (PhD 1992). "Compact Objects in the Disk and Globular Clusters". Worked on X-ray binaries for PhD. Senior lecturer in the School of Physics at University of Sydney.

4. Anderson, Stuart (PhD 1993; co-advised with T. A. Prince). "A Study of Recycled Pulsars in Globular Clusters". Pioneering application of super computing to pulsar research (with a trove of globular cluster pulsar discoveries). Currently, heading data analysis for LIGO (Laser Interferometer Gravitational Wave Observatory).

5. Navarro, Jose (PhD 1994). "A Wide-bandwidth Pulsar Timing Machine". Built high speed (ECL) correlator for pulsar timing for PhD. After a Jansky Fellowship at NRAO moved to Norway to work in oil industry. Chief Scientist, Kongsberg

Norcontrol IT, Norway

6. Ray, Paul (PhD 1995; co-advised with T. A. Prince). "High Sensitivity Searches for Radio Pulsars". Pulsar searches, both field and targeted. Now staff at Naval Research Laboratory.

7. Danner, Rudolf (PhD 1996; co-advised with A. J. Buras). "X-ray Emission from Old Neutron Stars". PhD centered on investigations of stellar sources with ROSAT. Now at Northrop Grumman Aerospace Systems.

8. Vasisht, Gautam (PhD 1998). "The Many Faces of Neutron Stars". Thesis centred on supernova remnants and magnetars. Now staff astronomer at the Jet Propulsion Laboratory and working on spatial interferometry and high contrast imaging.

9. Oppenheimer, Rebecca (PhD 1999). "Direct Detection of Brown Dwarf Companions of Nearby Stars". Thesis was on high dynamic range imaging of nearby stars (which lead to the discovery of the first brown dwarf). *Winner of the 2009 Blavanik Award for Young Scientists*. Curator in the Department of Physical Sciences of the American Museum of Natural History, New York, New York, US

10. Sandhu, Jagmit Singh (PhD 2001). "High Precision Dual Frequency Timing of Millisecond Pulsars" (co-directed by R. N. Manchester). For PhD focused on precision pulsar timing. Currently staff at the Jet Propulsion Laboratory.

11. Bloom, Joshua Simon (PhD 2002). "Towards an Understanding of the Progenitors of Gamma-Ray Bursts" Worked on afterglow of gamma-ray bursts (which had been discovered at the start of his thesis). Professor, University of California, Berkeley, *A.P. Sloan Foundation Fellow, AAS Newton Lacy Pierce Prize. Co-founder: Wiso.io*

12. Lane, Benjamin F. (PhD 2003). "High Precision Stellar Interferometry". Developed phase referencing for the Palomar Testbed long-baseline infra-red intereferometer (a first). Principal Scientist, Draper Laboratory, Cambridge, US

13. Price, Paul (PhD 2003; co-advised with B. Schmidt, Mount Stromlo Observatory). "Gamma Ray Bursts". Astronomical Software Scientist, Princeton University

14. Berger, Edo (Phd 2004). "Gamma Ray Bursts: The Beast and Lair". Thesis focused on observational gamma-ray burst research. *2007 Trumpler award of ASP for Outstanding PhD Thesis*. Now a well recognized leader in time domain astronomy Professor of Astronomy, Harvard University

15. Kaplan, David Laor (PhD 2004). "Diversity in Neutron Stars". Thesis focused on searches for neutron stars in young remnants shining in the X-ray. *Milton and Francis Clauser Doctoral Dissertation Prize (Caltech).* Associate Professor of Astronomy at Univeristy of Wisconsin, Milwaukee. Project Scientist, Murchison Wide Field Array

16. Jacoby, Bryan (PhD 2005). "Precision Pulsar Timing". Pulsar searching at Parkes Observatory. Engineering specialist at the Aerospace Corporation, Virginia, US

17. Soderberg, Alicia Margarita (PhD 2007). "GRB-Supernova connection". Focused on identifying low luminosity gamma-ray bursts using radio searches of supernovae. *A.P. Sloan Foundation Fellow, Packard Foundation Fellow, AAS Annie Jump Cannon Prize, IUPAP Young Scientist Prize*. Associate Professor of Astronomy at Harvard University.

18. Cameron, P. Brian (PhD 2008) "Astrometry with Adaptive Optics". Precision infra-red astrometry using laser guide star adaptive optics system. Director, Aerospace Corporation, Virginia, US.

19. Wiktorowicz, Sloane (PhD 2008). "Unambiguous Black Hole Mass from Polarimetry & Application to Hot Jupiters". Built a differential polarimeter for sensitive polarization observations of binary stars. Sagan Fellow, UC, Santa Cruz, US

20. Cenko, S. Bradley (PhD 2008; co-advised with F. Harrison). "Gamma ray bursts"S. Bradley Cenko. Robotocized the Palomar 60-inch telescope for rapid follow-up of gamma-ray bursts. Deputy Project Scientist, Swift X-ray Observatory, Goddard Space Flight Center, Greenbelt, Maryland, US

21. Busch, Michael (PhD 2010). "Shapes & Spins of near-earth asteroids". Invented speckle reflection of radar return from asteroids as a waye to determine orientation of asteroid spin. Research scientist, SETI Institute, Mountain View, US

22. Kasliwal, Mansi Manoj (PhD 2011). "Transients in the Local Universe"
Help develop and commission Palomar Transient Factory. Asst. Prof. of Astronomy, Caltech, Pasadena, US

23. Bhalerao, Varun (PhD 2012) "Neutron stars and NuSTAR" (co-advised with F. Harrison). Calibration of Cadmium-Zinc-Tellurium for NuSTAR and observations of neutron stars. Used his training at Caltech to calibrate the detectors on India's first astronomy satellite, ASTROSAT. Currently, Vaidya Rayachaudhuri Fellow, Inter-University Center for Astronomy & Astrophysics (IUCAA), India

24. Tendulkar, Shriharsh (PhD 2013). " Beyond the blur: Construction and characterization of the first autonomous AO system and An AO survey of magnetar proper motions". His thesis consisteted of dvelopment of a robotic adaptive optics system followed by Keck LGS astrometry of magnetars. Post-doctoral fellow, McGill University (working on commissioning CHIME for pulsar and FRB observations).

25. Adam Wasczack (PhD 2015). "Solar System Small-Body Demographics with the Palomar Transient Factory Survey". Developed algorithms (Machine Learning) to identify near-earth asteroids in PTF data and studied main belt comets. Now data scientist at Analytics Media Group, New York

26. Mooley, Kunal P. (PhD 2015; co-advised with G. Hallinan). "Exploring the Dynamic Radio Sky: The Search for Slow Transients with the VLA". Developed On-The-Fly Mosaicing for high speed mapping with the Very Large Array (a key development for the soon-to-be-started VLA Survey of the Sky) and undertook the largest survey (to date) on transients in the GHz sky. Heinze Post-doctoral Fellow, Oxford University

27. Michael Bottom, (PhD 2016; co-advised by J. Johnson). "Characterization of extra-solar planets by coronagraphy". Developed Stellar Double Coronagraph (a platform for a variety of coronagraphic implementations) for high contrast images of nearby stars and contributed to the development of radial velocity facility based on small telescopes. Staff at the Jet Propulsion Laboratory

28. Cao, Yi (PhD 2016) "Cosmic Explosions: Observations Of Infant Hydrogen-Free Supernovae Towards an Understanding of Their Parent Systems". Implemented robust and rapid real time pipelines to identify transients (supernovae) within hours of explosions and showed that type Ia supernovae have two progenitor channels. "eScience" Fellow at the University of Washington, Seattle (computer science & astronomy & biology)

Postdoctoral Fellows:

1. Steve Thorsett (1991-1994; Millikan Fellow). President, Willamette College, Oregon. *A.P. Sloan Foundation Fellow*

2. Chris Haniff (circa 1990; NATO Fellow). Professor, Department of Physics, Cambridge University
3. Tadashi Nakajima (1993-1996). Astronomer, National Astronomical Observatory of Japan
4. M. Vivekanand (circa 1991). Retired from National Centre for Radio Astronomy, India
5. J. Anthony Phillips (1992-1994).
6. Fiona Harrison (1993-1995; Millikan Fellow). Professor & Division Chair, Caltech.
7. Thomas Hamilton (1994-1998). RAND Corporation, Santa Monica, California.
8. Marten van Kerkwijk (1994-1996; Hubble Fellow). Professor, Department of Astronomy, U. Toronto. *Guggenheim Fellowship*

9. Victoria Kaspi (1994-1996; Hubble Fellow). Lorne Trottier Chair, Canada Research Chair and Professor, Department of Physics, McGill University, Canada. *2016 winner (first woman ever) of the $1M Gerhard Herzberg Medal of NSERC Canada*.

10. J. Christopher Clemens. Professor and Chair, Department of Physics & Astronomy, U. North Carolina. Founder of MegaWatt Solar Inc, and Syzygy Optics, Inc.

11. Michelle Creech Eakman. Professor, New Mexico Mining Technology

12. Chris Koresko. Industry, Fairfax County, Maryland.

13. Alan Diercks (1990). Seattle Biomedical Research Institute.

14. Titus Galama (1999-2002). Senior Economist, U. Southern California, Los Angeles, US

15. Daniel Reichart (Hubble Fellow, 2000-2002). Bowman & Gordon Gray Professor, Department of Physics & Astronomy, U. North Carolina, Director of the Morehead Observatory

16. Maria Osorio-Zapatero (1999-2002). Staff Astronomer, Centro de Astrobiologia, Madrid, Spain

17. Matthew Britton (2000-2003). Senior Engineering Specialist, Aerospace Corporation, Los Angeles, US

18. Jean-Luc Margot (2000-2004). Professor of Earth & Planetary Sciences, UCLA, Los Angeles, US

19. Robert Rutledge (2000-2004). Professor of Astronomy, McGill University, Montreal, Canada. *Founder and Editor-in-Chief of The Astronomer's Telegram (principal distribution mechanism for results on astronomical transients)*

20. James Lloyd (Millikan Fellow, 2002-2004). Professor of Astronomy, Cornell University, Ithaca, US

21. Derek Fox (2000-2005). Professor of Astronomy, Penn State University, State College, US. *2007 APS ROSSI Prize*

22. Chris Gelino (2002-2005). Staff member, IPAC, Caltech, Pasadena

23. Maciej Konacki (Michelson Fellow, 2000-2005). Assoc. Professor, Nicolaus Copernicus Astronomical Center, Torun, Poland

24. Dae-Sek Moon (Millikan Fellow, 2003-2006). Professor of Astronomy, U. Toronto, Canada

25. Michael Ireland (Michelson Fellow, 2005-2007). Future Fellow, Research School of Astronomy and Astrophysics, ANU, Canberra, Australia

26. J-P Macquart (Jansky Fellow, 2004-2007). Senior Research Fellow, Curtin University, Perth, Australia

27. Arne Rau (2005-2008). Staff Scientist, Max Planck Institute for Extra-terrestrial Physics, Garching, Germany

28. Nicholas Law (2006-2009). Professor, UNC-Chapel Hill

29. Eran Ofek (Einstein Fellow, 2007-2011). Professor, Weizmann Institute of Science, Israel

30. Robert Quimby (2007-2011) Professor, San Diego State University, California

31. Alessandra Corsi (2010-2012), Assistant Professor, Physics, Texas Tech University, Lubbock, Texas, US

32. Assaf Horesh (2010-2013) Asst. Prof., Hebrew U. of Jerusalem, Israel

33. Christopher Baranec (2007-2013). Asst. Prof, U. Hawaii. *A.P. Sloan Foundation Fellow*.

34. Nick Konidaris (2011-2013). PlanetLab, Silicon Valley, California

35. Sumin Tang (2012-2014). Facebook, Silicon Valley, California

36. Sarah Burke Spolaor (2013-2014). Astronomer, National Radio Astronomy Observatory

37. Daniel Perley (2011-2015; Hubble Fellow). DARK/Marie Curie Fellow, DARK Cosmology Center, Niels Bohr Institute, Copenhagen, Denmark. Shortly starting as Lecturer, Liverpool John Moore University, UK

38. Samaya Nissanke (2011-2013). Astrophysicist, Radboud University, Netherlands

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IV. Optional questions

You are encouraged to elaborate your recommendation by answering any or all of the following optional questions. Your responses could assist the judges in appreciating particular strengths of the nominee and will also assist *Nature* in its coverage of the awards:

1. **Please provide examples of mentoring (e.g. critical moments or sustained interactions) that illustrate your approach to successful mentoring.**

The best positive moment is when I was aware that there was either a discovery or signs of a discovery present in the data but elected not to disclose this finding to the student (or postdoc). I let them figure out and make the discovery.

The most useful "negative" moment is to let particularly confident or arrogant young student make a big mistake and then use the occasion to teach lessons in humility. Such moments are useful since motivated and energetic students also tend to be immature. It is my observations that most people, especially the brightest, only learn from mistakes.

2. **Please identify aspects of practice and (if you wish) personality that make you a successful mentor.**

Necessarily, styles of mentoring will be different for different advisors and different students. Many advisors view students as "pairs of hands" that will assist them in making *their* (as in advisor) dream come true. This approach may once in a while produce good students but more likely than not. The key to good mentoring is place the long term interests and career of your mentee ahead of your own research goals and ambitions.

3. Please identify any lessons that could be passed on to others as a result of your success at mentoring.

The primary lesson I can pass on to my younger colleagues is to urge them to ask the following question and answer it honestly: decide whether you value your accomplishments over training the next generation of scholars. Read the rest of this write up if your honest answer is the latter.

4. Has anyone inspired your approach to mentoring? If so, how?

My approach to mentoring was inspired by my two co-advisors: Carl Heiles & Donald Backer, both of the Radio Astronomy Laboratory at UC, Berkeley. It was further aided by the ambience and atmosphere of the Laboratory that Jack Welch promoted, namely, learning was more important in the long run over than having the group accomplish tasks by deadlines (as in many "industrial" large labs that pervade in Numerical Astrophysics, Cosmography, Chemistry and Biology).

In particular, I was keen to learn all techniques of radio astronomy as my thesis goal and Heiles let me pursue this at my own pace. I did not deliver much for the first four years but in the final year I completed an air-linked radio interferometer in Puerto Rico (Arecibo Observatory), invented a new mode of operation for the then newly commissioned Very Large Array (in New Mexico), discovered the first millisecond pulsar and wrote a seminal and durable review on the Galactic interstellar medium (with Heiles). I remain indebted to Heiles & Backer for supporting my long bet.

5. A final question: Are there other initiatives supportive of mentoring that you would like to mention?

Research accomplishments are recognized by in many tangible and major ways: famous prizes and as inputs for hiring and promotion. The best mentors necessarily share the fruits of their work with students and postdoctoral fellows. As a result their "personal" research is usually not as impressive as that of researchers who are single-minded about achieving a specific (and usually great) objective. The solution is simple: recognize excellent mentoring in the same way high impact research is recognized. In this respect, this very competition organized by Nature is an excellent start. More such initiatives are needed.

Abstractions

CONTRIBUTING AUTHOR
Shri Kulkarni, professor of astronomy at the California Institute of Technology, has an abundant publication record thanks, in part, to his attitude towards graduate students and postdocs. Since 1982, he has chalked up some 200 articles and reviews. Hard work is part of it but, more importantly, Kulkarni gives graduate students a greater role in the process than many senior scientists give their protégés.

Kulkarni is also a proponent of learning different observational techniques. In the paper on page 845, his group uses four different methods to observe short, intense γ-ray bursts that result from the merger of neutron stars or black holes.

Why so many observational techniques for this paper?
A lot of people stick to one kind of instrument or another. Having a whole bunch of tool kits gives you more opportunities.

Why did you learn them all?
I have an attention deficit syndrome. Every three to five years I feel it's time to move on. It's not a value judgment or anything. It's just me.

What sort of scientific advantages does switching techniques and research goals provide?
Part of my strategy is to get ahead in new fields. I have so many weaknesses. But one thing I have reasonable luck in is identifying new opportunities a couple of years or a couple of months before others — and being there.

Why not just pursue obvious targets?
I don't do 'me too' stuff. You really have to know something special in an existing field.

How have you been able to pick up new sub-disciplines and tools?
I have a lot of bright young people in my group and they really keep me alive this way.

What role do graduate students and postdocs play in your research and publication?
I tell them: "You're the one who will trigger the great telescope. You're the one who will write the submission letter, deal with referees..." I have almost all graduate students in their second year submit a paper. But it's not like the students are thrown in the water and then are asked to thrash around.

How has this approach contributed to your publication record and overall output?
The top-ranking students, they talk among themselves. If they hear they can be first author of a big paper in a high-profile journal, they will consider joining my lab. I get lots of ambitious, self-driven students. ■

MAKING THE PAPER

Kazushige Touhara

In search of the chemicals that guide mating in mice.

A trail of tears has led a team of Japanese researchers to an unusual aspect of courtship in mice, details of which are published on page 898 of this issue.

The group, led by Kazushige Touhara at the University of Tokyo, had been investigating the chemical signals used by mice to recognize a potential mate. The team's first port of call was a selection of chemicals that had previously been flagged up as potential mouse pheromones. But when they began studying these compounds, the researchers discovered that they didn't really fit the bill. The compounds did not seem to be recognized by the organ in the nose associated with pheromone detection in behaving mice. There was only one conclusion. "There must be other pheromones," Touhara thought.

And so the hunt began. The first place the scientists looked was in mouse urine, but they found no suitable candidates there. Then Hiroko Kimoto, one of Touhara's graduate students, examined a little-known gland below the ear and got a promising response. Turning to a book on mouse anatomy, she realized that this gland was a type of tear gland.

"It took time to identify the secreting organ, because nobody expected the pheromone to be released from the eyes," Touhara says. "Apparently, no one has looked at this gland closely before."

The researchers investigated further and were surprised to find that the active substance secreted by the gland was non-volatile. This is unusual for pheromones, as they are usually volatile compounds that are detected by the nose. If the new compound was the elusive mouse pheromone, mice would have to detect it by touch.

To confirm the team's suspicions, Kimoto set about purifying the peptide, now named ESP1.

Kazushige Touhara and some of his mice.

This was an involved process, and meant extracting the peptide from some 80 mice. The team then tested each fraction on mice to see whether it caused gene expression associated with pheromone recognition. This stage took about a week per mouse and required scores of mice to get a statistically significant result.

But even with positive data from this work, the researchers couldn't be certain that ESP1 was a pheromone — the gene-expression work could not prove that the peptide generated an electrical signal in the pheromone-detecting tissue in the mouse nose. "The electrophysiology that we show in the paper was an important experiment to prove that the isolated pheromone was real," Touhara says. Koji Sato did these experiments, and Sachiko Haga found that ESP1 is indeed recognized by a suspected pheromone receptor.

Although the team is confident it has now found its pheromone, Touhara says that there is a lot of work ahead. He wants to look at the evolution and function of the ESP gene family, and pick apart its neurological mechanisms. Ultimately, he would like to find out more about ESP1's receptor and how the peptide binds to it, and reveal where the signal is integrated in the brain and what effects it has on behaviour. ■

QUANTIFIED **BRAZIL**

A numerical perspective on *Nature* authors.
Founded in the late eighteenth century, Brazil's National Museum is the oldest scientific institution in Latin America. Now run by the Federal University of Rio de Janeiro, it houses more than 20 million specimens from around the world. Working at the museum, says Alexander Kellner, means a combination of curatorial and teaching work.

Like most museums in Brazil, Kellner says that the National gives its staff free rein to follow their research interests. For Kellner, this is the evolution of pterosaurs (flying reptiles), and on page 875 he and his team present their latest findings from China, where they discovered two new pterosaurs. The fossils show that some 120 million years ago, flying reptile groups were more diverse than expected. They also offer fresh insights into the competition between pterosaurs and birds.

2 papers in *Nature* this week have contributing authors who are working in Brazil.

54 submissions made to *Nature* so far this year have come from Brazil (total submissions to date = 10,451).

6 Brazilian institutions have had papers published in *Nature* this year.

23,011 visits to www.nature.com were made, on average, each week from people based in Brazil during September 2005.

CURRICULUM VITAE – Shrinivas R. Kulkarni

Cahill Astrophysics 249-17, California Institute of Technology, Pasadena CA 91125
srk @ astro.caltech.edu http://www.astro.caltech.edu/∼srk (626) 395-3734/4010 Aug, 2016

Education & Early Career

1978	M.S. (Physics), Indian Institute of Technology, New Delhi
1983	Ph.D. (Astronomy), University of California at Berkeley
1983-1985	Postdoctoral Fellow, UC Berkeley
1985-1987	Millikan Fellow, Caltech
1987–present	Faculty in the Astronomy Department, Caltech

Current Position

2006-	Director, Caltech Optical Observatories
2004-	Director, NASA Exoplanet Science Center (nee Micheslon Science Center)
2001-	McArthur Professor of Astronomy & Planetary Sciences, Caltech

Research Interests

Cosmic Explosions, Gamma Ray Bursts, Optical Transients
Neutron stars-Pulsars, Millisecond Pulsars, X-ray Binaries
Instrumentation and Signal Processing

Selected Honors and Awards

2016	Elected as Fellow of the Royal Netherlands Academy of Arts & Sciences
2012	Elected as Honorary Member, Indian Academy of Sciences
2010	Eddington Lecturer, Cambridge University, UK
2009	Gordon Lecturer, National Astronomy & Ionospheric Center, Cornell University
2003	Elected as Member, National Academy of Sciences
2002	Jansky Lecturer, Associated Universities, Inc.
2001	Elected as Fellow, Royal Society of London
1994	Fellow, American Academy of Arts and Sciences
1992	NSF Alan T. Waterman Prize
1991	Helen B. Warner Prize, American Astronomical Society

Citizenship: United States of America. In addition, I hold a Person of Indian Origin card.

Mentoring: Supervised and mentored 28 students and 39 postdoctoral fellows.
`http://www.astro.caltech.edu/∼srk`

Publications: 486 refereed papers and 36,000 citations. h-index=97. The sixty three papers published in Nature have garnered 10,712 citations.

Some Key Papers

B1 Backer, D.C., Kulkarni, S.R., Heiles, C.E., Davis, M.M., and Goss, W.M., 1982, *Nature* **300**, 615, "A Millisecond Pulsar"

B2 Kulkarni, S.R., 1986, *Astrophys. J.* **306**, L85, "Optical Identification of Binary Pulsars: Implications for Magnetic Field Decay in Neutron Stars"

B3 Nakajima, T., Oppenheimer, B. R., Kulkarni, S. R., Golimowski, D. A., Matthews, K. & Durrance, S. T. 1995, *Nature* **378**, 463, "Discovery of a cool, brown dwarf"

B4 Metzger, M. R., Djorgovski, S. G., Kulkarni, S. R., Steidel, C. C., Adelberger, K. L., Frail, D. A., Costa, E. & Frontera, F., 1997, *Nature* **387**, 878, "Spectral constraints on the redshift of the optical counterpart to the γ-ray burst of 8 May 1997"

B5 Kulkarni, S. R., Frail, D. A., Wieringa, M. H., Ekers, R. D. Sadler, E. M., Wark, R. M., Higdon, J. L., Phinney, E. S. & Bloom, J. S. 1998, *Nature* **395**, 663, "The gamma-ray burst of 980425 and its association with the extraordinary radio emission from a most unusual supernova"

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