Urvashi Rau

Associate Scientist (Computational Science)
National Radio Astronomy Observatory,
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Research Interests

Algorithm research and software development for image reconstruction, signal calibration and image/data analysis, applied to radio interferometers and radio astronomy.

- Application of numerical optimization techniques to inverse problems in signal and image reconstruction.
- Algorithms for the detection and removal of electromagnetic interference.
- Algorithms for calibration of radio-frequency receivers.
- Parallel and high-performance computing, machine learning and automation, data visualization.

Educational Qualifications

Ph.D. Physics Aug 2004 - May 2010
New Mexico Institute of Mining and Technology, Socorro, NM, USA
Dissertation: "Parameterized Deconvolution for Wide-Band Radio Synthesis Imaging"

M.S. Computer Science (Scientific Computing) Sep 2002 - Jun 2004
University of California, San Diego, CA, USA
Thesis: "A performance model and load balancer for a Parallel Monte-Carlo Cellular Microphysiology Simulator"

M.Sc.(Hons.) Physics & B.E.(Hons.) Computer Science Aug 1997 - Jun 2002
Birla Institute of Technology and Science, Pilani, India

Work Experience

- **Associate Scientist - CS**, National Radio Astronomy Observatory, Socorro [Apr 2014 - present]
- **Assistant Scientist - CS**, National Radio Astronomy Observatory, Socorro [Aug 2010 - Mar 2014]
- **NRAO Reber Fellow**, National Radio Astronomy Observatory, Socorro [Jan 2008 - May 2010]
- **Graduate Intern**, National Radio Astronomy Observatory, Socorro [Aug 2007 - Dec 2007] [Jul 2003 - Sep 2003]
- **CASA Programmer**, National Radio Astronomy Observatory, Socorro [Sep 2004 - Jul 2007]
- **Teaching Assistant** Dept. of Computer Sc. & Engineering., UC San Diego [Apr 2004 - Jun 2004] [Apr 2003 - Jun 2003]
- **Research Assistant** Dept. of Computer Sc. & Engineering., UC San Diego [Sep 2003 - Mar 2004] [Sep 2002 - Mar 2003]
- **Undergraduate Intern**, National Centre for Radio Astrophysics, Pune [Jan 2002 - Jun 2002]

Journal Publications

- *"Direction-dependent Corrections in Polarimetric Radio Imaging. I. Characterizing the Effects of the Primary Beam on Full-Stokes Imaging "*, Jagannathan, P.; Bhatnagar, S.; **Rau, U.**; Taylor, A. R. The Astronomical Journal, Volume 154, Issue 2, article id. 56, 8 pp., August 2017
- *"Understanding Systematic Errors Through Modeling of ALMA Primary Beams"*, K.Kundert, **U.Rau**, S.Bhatnagar, E.J.Bergin, IEEE Transactions on Antennas and Propagation, Vol 65 issue 2, pp. 644-653, Feb 2017
- *"Automated Tuning of RFI Identification and Flagging Algorithms"*, Bruno J. Martins, **U.Rau**, IEEE 2016 Radio Frequency Interference (RFI), Socorro, NM, 2016, pp. 59-64.
- *"VLA and ALMA Imaging of Intense Galaxy-wide Star Formation in z 2 Galaxies"* , Rujopakarn, W.; Dunlop, J. S.; Rieke, G. H.; Ivison, R. J.; Cibinel, A.; Nyland, K.; Jagannathan, P.; Silverman, J. D.; Alexander, D. M.; Biggs, A. D.; Bhatnagar, S.; Ballantyne, D. R.; Dickinson, M.; Elbaz, D.; Geach, J. E.; Hayward, C. C.; Kirkpatrick, A.; McLure, R. J.; Michaowski, M. J.; Miller, N. A. Narayanan, D.; Owen, F. N.; Pannella, M.; Papovich, C.; Pope, A.; **Rau, U.**; Robertson, B. E.; Scott, D.; Swinbank, A. M.; van der Werf, P.; van Kampen, E.; Weiner, B. J.; Windhorst, R. A., The Astrophysical Journal, Vol 833, Issue 1, article id. 12, 11 pp., December 2016
- *"Deep wideband single pointings and mosaics in radio interferometry : How accurately do we reconstruct intensities and spectral indices of faint sources ?"*, **U.Rau**, S.Bhatnagar, F.N.Owen, Astronomical Journal, Volume 152, No. 5, October 2016
- *"Efficient implementation of the adaptive scale pixel decomposition algorithm"*, L.Zhang, S.Bhatnagar, **U.Rau**, M.Zhang, Astronomy and Astrophysics, Volume 592, August 2016
- *"The population of compact radio sources in the Orion Nebula Cluster (& VizieR Online Data Catalog)"*, J.Forbrich, V.M.Rivilla, K.M.Menten, M.J.Reid, C.J.Chandler, **U.Rau**, S.Bhatnagar, S.J.Wolk, S.Meingast, Astrophysics Journal, Vol 822, No.2, May 2016
- *"The non-thermal superbubble in IC 10: the generation of cosmic ray electrons caught in the act"*, Volker Heesen, Elias Brinks , Martin G. H. Krause , Jeremy J. Harwood ,**Urvashi Rau** , Michael P. Rupen , Deidre A. Hunter , Krzysztof T. Chyzy , Ged Kitchener, MNRAS Volume 447,No. 1, L1-L5, February 2015
- *"Wideband Very Large Array Observations of A2256. I. Continuum, Rotation Measure, and Spectral Imaging"*, Owen, Frazer N.; Rudnick, Lawrence; Eilek, Jean; **Rau, Urvashi**; Bhatnagar, Sanjay; Kogan, Leonid, The Astrophysical Journal, Volume 794, Issue 1, article id. 24, 14 pp., October 2014.
- *"Wide-field wide-band full polarization interferometric imaging: The WB A-Projection algorithm"*, Bhatnagar,S. , **Rau,U.**, Golap,K. ,Astrophysical Journal, Volume 770, issue 2, id 91, pp.9, June 2013.
- *"A Group Sparsity Imaging Algorithm for Transient Radio Sources"*, Wenger, S., **Rau,U**, Magnor,M., Astronomy and Computing, Volume 1, pp 40-45, February,2013.
- *"A multi-scale multi-frequency deconvolution algorithm for synthesis imaging in radio-interferometry"*, **U.Rau**, T.J.Cornwell, Astronomy and Astrophysics, Volume 532, A71, August 2011.
- *"Deep Radio Continuum Imaging of the Dwarf Irregular IC 10: Tracing Star Formation and Magnetic Fields"*, Volker Heesen, **U. Rau**, Michael P. Rupen, Elias Brinks, Deidre Hunter, The Astrophysical Journal Letters, Volume 739, Issue 1, L23, September 2011.
- *"EVLA Observations of Galactic Supernova Remnants: wide-field continuum and spectral-index imaging"*, Sanjay Bhatnagar, **U. Rau**, David A. Green, and Michael P. Rupen, The Astrophysical Journal Letters, Volume 739, Issue 1, L20, September 2011.

- *"SparseRI: A Compressed Sensing Framework for Aperture Synthesis Imaging in Radio Astronomy"*, Wenger, S. Magnor, M. Pihlstrm, Y. Bhatnagar, S. **Rau, U.**, Publications of the Astronomical Society of the Pacific, Volume 122, issue 897, pp.1367-1374.
- *"Advances in Calibration and Imaging Techniques in Radio Interferometry"*, **U.Rau**, S.Bhatnagar, M.A.Voronkov, T.J.Cornwell, Proceedings of the IEEE, Vol.97, No.8, p-1472, August 2009.

Conference Proceedings

- *"Direction-Dependent Effects In Wide-Field Wideband Full-Stokes Radio Imaging"*, Jagannathan, P.; Bhatanagar, S.; **Rau, U.**; Taylor, R., Astronomical Data Analysis Software an Systems XXIV (ADASS XXIV), Astronomical Society of the Pacific, p379, September 2015.
- *"Wideband Mosaic Imaging with the VLA - quantifying faint source imaging accuracy"*, **Rau, U**; Bhatnagar, S; Owen, F. N., Bulletin of the Astronomical Society of India, March 2014
- *"Radio interferometric imaging of spatial structure that varies with time and frequency"*, **U.Rau**, Proc. SPIE 8500, Image Reconstruction from Incomplete Data VII, 85000N, October 15, 2012.
- *"Monte-Carlo Image analysis in Radio Interferometry"*, **U.Rau**, T.J.Cornwell, Astronomical Data Analysis Software and Systems XIV ASP Conference Series, Vol. 347, p-168, 2004
- *"Solving for Polarization Leakage in Radio Interferometers Using Unpolarized Sources"*,Bhatnagar S., **Urvashi R.V.**, Nityananda R., Astronomical Data Analysis Software and Systems XII ASP Conference Series, Vol. 295, p-469, 2003.

AAS Abstracts / Posters

- *"Direction Dependent Effects In Widefield Wideband Full Stokes Radio Imaging"*, Jagannathan, Preshanth; Bhatnagar, Sanjay; **Rau, Urvashi**; Taylor, Russ, American Astronomical Society, AAS Meeting #225, id.336.31, January 2015
- *"A Radio Continuum Study of Dwarf Galaxies: 6 cm imaging of LITTLE THINGS"*, Kitchener, Ben; Brinks, Elias; Heesen, Volker; Hunter, Deidre Ann; Zhang, Hongxin; **Rau, Urvashi**; Rupen, Michael P.; Little Things Collaboration American Astronomical Society, AAS Meeting #225, id.248.16 , January 2015
- *"Rotation Measure Synthesis of Cassiopeia A"*, DeLaney, Tracey; Stadelman, Matthew; Rudnick, Lawrence; Rupen, Michael P.; **Rau, Urvashi**; Bhatnagar, Sanjay; Greisen, Eric; Petre, Robert American Astronomical Society, HEAD meeting #14, id.120.15, August 2014
- *"Using Rotation Measure Synthesis to Study Shocks in Cassiopeia A"*, Stadelman, Matt; DeLaney, T.; Rupen, M. P.; Rudnick, L.; **Rau, U.**; Bhatnagar, S.; Greisen, E.; Petre, R. American Astronomical Society, AAS Meeting #223, id.353.06, January 2014
- *"Quantifying Deep-Imaging Limits of the VLA"*, Mayeshiba, Julia; Mayeshiba, J.; **Rau, U.**; Owen, F. N. American Astronomical Society, AAS Meeting #223, id.255.07, January 2014
- *"Deep Radio Continuum Imaging Of The Dwarf Irregular Galaxy IC 10: Tracing Star Formation And Magnetic Fields"*, Heesen, Volker; **Rau, U.**; Rupen, M. P.; Brinks, E.; Hunter, D. A. American Astronomical Society, AAS Meeting #219, id.148.08, January 2012
- *"Comparison and Verification of RFI Excision Techniques"*, Houston, Caroline; **Rau, Urvashi** American Astronomical Society, AAS Meeting #219, id.145.07, January 2012

- *"Wide-Field Wide-Band Imaging With The EVLA : Initial Results With Images And Error Estimates"*, **Rau, Urvashi** American Astronomical Society, AAS Meeting #215, id.357.01; Bulletin of the American Astronomical Society, Vol. 42, p.540, January 2010

Theses

- *"Parameterized Deconvolution for Wide-Band Radio Synthesis Imaging"*, **Urvashi R.V.**, Ph.D. Dissertation, New Mexico Institute of Mining and Technology, Socorro, NM, USA, May 2010.
- *"A performance model and load balancer for a Parallel Monte-Carlo Cellular Microphysiology Simulator"*, **Urvashi R.V.**, M.S. Thesis, University of California, San Diego, June 2004.

Technical Memos and Presentations

- *"Synthesis Imaging chapters for CASA documentation "*, 9 out of the 12 initial CASAdocs pages on Imaging algorithms and available options and tasks within CASA.
- *"How the CASA Imager uses the parallelization infrastructure "*, Presentation to the CASA HPC Team, 24 March 2015, Socorro, NM, USA.
- *"Imaging: status priorities, issues "*, Presentation to CASA Users Committee, 23 September 2014, Socorro, NM, USA.
- *"Convention for UVW calculations in CASA"*, **U.Rau**, CASA Memo, 2013.
- *"Flagging in CASA 3.4"*, S.Castro, **U.Rau**, J.Gonzales, CASA documentation, 2012/2013.
- *"Imaging Algorithms in CASA"*, **U.Rau**, CASA documentation, 2010/2011/2012/2013.
- *"Casapy Flag tool and casa::Flagger"*, **U. Rau**, CASA Programmers Note, 23 August 2007
- *"Design of casa::TablePlot for Casapy"*, **U. Rau**, CASA Programmers Note, 18 August 2007
- *"Multi Frequency Synthesis Imaging for the EVLA : An initial investigation"*, **Urvashi R.V.**, T.J.Cornwell, S.T.Myers, EVLA Memo 101, April 2006
- *"Monte Carlo Methods for Bayesian Image Reconstruction and Analysis in Radio Astronomy"*, **Urvashi R.V.**, T.J.Cornwell, EVLA Memo 102, February 2006
- *"Automatic RFI identification and flagging"*, **Urvashi R.V.**, A. Pramesh Rao, NCRA Technical Report No. R00202, October 1 2003

Selected Research Talks

- *Combining single dish and interferometer data for joint wideband multi-term deconvolution "*, Talk at URSI - National Radio Science Meeting, 4 January 2018, Boulder, CO, USA.
- *"Automated Tuning of RFI Identification and Flagging Algorithms"*
  - URSI 2018 - National Radio Science Meeting, 6 January 2018, Boulder, CO, USA
  - RFI2016 - Coexisting with Radio Frequency Interference , 20 October 2016, Socorro, NM, USA.
- *"Radio Interferometric imaging of spatial structure that varies with time and frequency - Orion with the VLA "*, Talk at the 9th SKA Calibration and Imaging Workshop , 11 October 2016, Socorro, NM, USA.

- *"Understanding imaging limits due to approximatioms in ALMA primary beam models "*, Talk at the ALMA Future Science Development Program Workshop, 25 August 2016, Charlottesville, Virginia, USA.
- *"How accurately do our imaging algorithms reconstruct intensities and spectral indices of weak sources?"*
  - Wednesday-Lunch talk at the NRAO/SOC, 13 Nov 2013, Socorro, NM, USA
  - Talk at the 29th Annual New Mexico Symposium, 17 January 2014, Socorro, NM, USA
  - Talk at the 8th SKA Calibration and Imaging Workshop, 6 March 2014, Kiama, NSW, Australia (via Skype from Socorro)
  - Tuna Lunch talk at NRAO Charlottesville, 23 August 2016, Charlottesville, Virginia, USA.
- *"Wideband Mosaics - Accuracy of deep imaging surveys"* , Talk at the Meter Wavelength Sky conference, 12 Dec 2013, GMRT/NCRA, Pune, India.
- *"Wideband mosaics"*, Talk at the Seventh SKA Calibration and Imaging workshop (all participants invited), 5 December 2012, Cape Town, South Africa
- *"Radio Interferometric Imaging of spatial structure that varies with time and frequency"*,
  - Talk at the SPIE Optical Engineering+Applications Meeting, 15 August 2012, San Diego, CA, USA
  - Wednesday-Lunch talk at the NRAO/SOC, 29 August 2012, Socorro, NM, USA
  - Talk at the ATNF/CASS,CSIRO, 18 September 2012, Sydney,Australia.
- *"Sky-domain algorithms to reconstruct spatial, spectral and time-variable structure of the sky-brightness distribution"*, Colloquium at the National Centre for Radio Astrophysics, TIFR, 2 July 2012, Pune, India.
- *"Correcting for wide-band primary-beam effects during imaging and deconvolution"*, Wednesday Lunch talk at the NRAO/SOC, 28 March 2012, Socorro, NM, USA.
- *"Synthesis Imaging in Radio Astronomy - Reconstructing spatial and spectral structure of an astronomical source"*, Talk at the Biomedical and Astronomical Signal Processing (BASP) Frontiers Workshop (all participants invited), 06 September 2011, Villars, Switzerland.
- *"Multi-frequency synthesis and wide-field imaging with the EVLA"*, Talk at the URSI General Assembly, 17 August 2011, Istanbul, Turkey,
- *"Recent Imaging Results with EVLA data, and lessons learnt so far"*, Talk at the Sixth SKA Calibration and Imaging Workshop (all participants invited), 26 July 2011, Manchester, UK (via Skype).
- *"Pilot Project for an EVLA wide-band Galactic-plane survey : first results"* , Talk at the 26th Annual New Mexico Symposium, 5 November 2010, Socorro, NM, USA.
- *"A few imaging results using wide-band EVLA data"*, Wednesday Lunch talk at the NRAO/SOC, 3 November 2010, Socorro, NM, USA.
- *"Wide-field Wide-band image reconstruction with the EVLA"*, Physics Seminar at the Univ. of New Mexico Physics Dept., 30 September 2010, Albuquerque, NM, USA.
- *"Feasibility of wide-band imaging (using MS-MFS)"*, Talk at the Fifth SKA Calibration and Imaging workshop (all participants invited), 23 August 2010, Dwingeloo, The Netherlands.
- *"Wide-Field Wide-Band Imaging in Radio Interferometry"*, Colloquium at the National Centre for Radio Astrophysics, 12 July 2010, Pune, India
- *"Parameterized Deconvolution for Wide-Band Radio Synthesis Imaging"*, Colloquium / PhD Thesis defense, 17 May 2010, Socorro, NM, USA

- *"Wide-Field Wide-Band Imaging with the EVLA"*, Talk at the 215^{th} American Astronomical Society (AAS) meeting, 6 January 2010, Washington D.C., USA
- *"Wide-Field Wide-Band Imaging in Radio Interferometry"*, Talk at the ATNF Student Symposium, 16 June 2009, Sydney, AU (via audio link from Socorro)
- *"Remote Sensing, Image Making and Radio Telescopes "*, Colloquium at the New Mexico Tech Physics Department, 09 Apr 2009, Socorro, USA
- *"Wide-Field Wide-Band Imaging with the EVLA - initial results"*, Talk at the Fourth SKA Calibration and Imaging Workshop (all participants invited), 31 March 2009, Socorro, USA
- *"Multi Frequency Synthesis Imaging with Wideband EVLA data"*, Lunch Talk at the EVLA Advisory Committee Meeting, 19-20 March 2009, Socorro, USA
- *"Multi-Frequency Synthesis Imaging with Multi-Scale Deconvolution (EVLA, e-MERLIN)"*, Talk at the Workshop on Imaging and Calibration Algorithms for EVLA, eMERLIN and ALMA, 02 December 2008, Oxford, UK (via video link from Socorro)
- *"Multi-Frequency Synthesis Imaging with Wide-Band (E)VLA data"*, Talk at the 24th Annual New Mexico Symposium, 24 October 2008, Socorro, USA
- *"Multi-Frequency Synthesis Imaging with Multi-Scale Deconvolution"*, Invited Talk at the XXIX URSI General Assembly, 15 August 2008, Chicago, USA
- *"Wide-Band Imaging - Algorithms and Errors"*, Talk at the Third SKA Calibration and Imaging Workshop (all participants invited), 09 April 2008, Perth, AU
- *"Multi-Frequency Synthesis Imaging with Multi-Scale deconvolution"*, Talk at the Second SKA Calibration and Imaging Workshop, 05 December 2006, Cape Town, South Africa
- *"Wide Bandwidth Imaging: Challenges and prospects for the EVLA and beyond"* ,Talk at the URSI National Radio Science Meeting, 06 January 2006, Boulder, USA

Lectures at Interferometry Schools and Imaging Workshops

- *"Imaging and Image Analysis"*, Lecture at the VLA Data Reduction Workshop, 23 October, 2017
- *"Wide-band, wide-field and multi-scale imaging"*, Lecture at the NCRA-GMRT Radio Astronomy School, 7 September 2017 (remote talk from Socorro).
- *"Imaging and Deconvolution"*, Summer Student lecture, Socorro (June 2013, 2014, 2015, 2016, 2017)
- *"Wide Band and Full Beam Imaging"*, 15^{th} NRAO Synthesis-Imaging Workshop, 6 June 2016, Socorro
- *"RFI Identification and Automatic Flagging "*, Lecture at the VLA Data Reduction Workshop, 15 March 2016, Socorro
- *"Wide Bandwidth Imaging "*, 14^{th} NRAO Synthesis-Imaging Workshop, 19 May 2014, Socorro.
- *"Wide-band wide-field imaging (sky-domain) + RFI identification and flagging"*, EVLA Data Reduction Workshop, 9 April 2013, Socorro
- *"Deconvolution and wide-band imaging"*, Third-generation Calibration (3GC3) Interferometry School, 13 February 2013, Port Alfred, South Africa (via Skype from Socorro).

- *"Wideband Imaging"*, CSIRO Astronomy and Space Sciences Radio Astronomy School, 27 September 2012, Narrabri, NSW, Australia.
- *"Imaging and Deconvolution"*, CSIRO Astronomy and Space Sciences Radio Astronomy School, 25 September 2012, Narrabri, NSW, Australia.
- *"Wide Bandwidth Imaging"*, 13^{th} NRAO Synthesis Imaging Workshop, 31 May 2012, Socorro, NM, USA.
- *"Wide-band wide-field imaging (sky-domain) + RFI identification and flagging"*, EVLA Data Reduction Workshop, 24 Feb 2012, Socorro
- *"Wide-field Wide-band Imaging with the EVLA - II"*, EVLA Data Reduction Workshop, 15 September 2011, Socorro
- *"Wideband imaging with the EVLA"*, NRAO Algorithm R&D Group Lecture-series, 21 July 2011, Socorro

Reviewing Experience

- Astronomy and Astrophysics (2011 - 3, 2013 - 1, 2014 - 2, 2015-1, 2016-1)
- Publications of the Astronomical Society of the Pacific (2013 - 1)
- Monthly Notices of the Royal Astronomical Society (2013 - 1)
- Bulletin of the Astronomical Society of India (2011 - 1)

Students Mentored

- **Summer 2017:** Nikhil Naik, Undergraduate student at IIT, Kharagpur, India.
  Topic : Prototype wideband single dish and interferometer combination algorithms.
- **May 2017+**: External thesis committee member for PhD student at Yves Wiaux's BASP research group, Edinburgh, UK.
  Topic : A primal-dual algorithm for Hyper Spectral Imaging
- **Summer 2017:** Michael Lambert, Graduate student at Brigham Young University.
  Topic : Demonstration of RFI excision by subspace projection on real VLA data
- **Summer 2016:** Bruno Martins, Undergraduate student at University of South Santa Catarina, Brazil and an exchange student at University of Virginia, Charlottesville.
  Topic : Auto-tuning of RFI autoflag algorithms via machine learning and evolutionary algorithms
- **Summer 2013, Fall 2013, Summer 2014 :** Kara Kundert, Undergraduate student at Oberlin College, Ohio, USA / University of Michigan, Ann Arbor, USA
  Topic : Imaging accuracy and dynamic range limits due to ALMA antenna-to-antenna beam variations
- **Summer 2013 :** Julia Mayeshiba, Undergraduate student at University of Wisconsin, Madison, USA
  Topic : Simulations of imaging accuracy and confusion limits for the VLA
- **Summer 2011 :** Caroline Houston, Undergraduate student at Rochester Institute of Technology, NY, USA.
  Topic : Prototype and compare several linear algebraic RFI excision algorithms

Committee Service

- ngVLA Research Associate Search Committee (2017)
- CASA Lead Search Committee (2017)
- CASA Liaison Search Committee (2016)
- NRAO Scientist Performance Review Committee - SPRC (2016,2017)
- NRAO Observatory Science and Technical Council - OSTC (2015,2016,2017)
- NRAO Jansky Postdoc Selection Committee (2014,2015,2016)
- NAASC Sci-Staff Hiring Committee (2014)
- NRAO Student Programs Review Committee (2013)
- IAU Working Group tasked with proposing a consistent set of definitions of wideband flux density (member 2014+, Chair from 2015)

Education and Public Outreach

- Ongoing work to create and add a 'How we make images' page to the new NRAO webpages (2017+)
- Tour guide for the Very Large Array at open-house events in 2005, 2008, 2010.
- Coached two Science Olympiad teams from the Sarracino Middle School, Socorro, NM (2011, 2014)
- Remotely delivered lecture on *"A radio eye on the universe"* as part of the "Storming Aurora" conference organized by the Astronomy Club at the Birla Institute of Technology and Science, Goa, India, 17th November, 2012.
- Alumni web-lectures as part of the BITS-Embryo project (http://www.bitsembryo.org), aimed at introducing undergraduate students at the Birla Institute of Technology and Science, India, to current research and technology trends in various disciplines. (1) *"Remote Sensing At Its Extreme - the interdisciplinary nature of observational radio astronomy"*, BITS-Pilani, Nov 2007 and (2)*"Remote Sensing and Image Making"*, BITS-Goa, Jan 2009.
- An introductory lecture about the working of a radio interferometer, for a group of 16 high-school students who visited the NRAO, Socorro,NM in April 2009.

Fellowships/Awards/Funding

- ALMA Cycle 5 development proposal for Full Mueller Imaging with ALMA (P.I. S.Bhatnagar, $190,000) (Fall 2017 - Fall 2018)
- Travel grant from URSI Commission-J towards attending the URSI-GASS in Istanbul, Turkey (Aug 2011)
- NRAO Pre-Doctoral (Reber) Research Fellowship (Jan 2008 - Dec 2009)

Technical Schools Attended

- Ninth Synthesis Imaging Summer School, NRAO, Socorro, June 2004
- Introductory Astrophysics Summer School, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, India May 2000 - Jun 2000

Software Skills

- Programming languages : C, C++, Python
- Environments : Unix/Linux
- Data Analysis Packages : Matlab/Octave, Scipy/Numpy, CASA, AIPS
- Libraries : GNU Scientific Library, Numerical Recipes, Bayesys, MPI