

# Rajat Mani Thomas

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CONTACT INFORMATION Netherlands Institute for Neuroscience  
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OBJECTIVE  
I should like to contribute in unique ways to research projects that can benefit from an integration of my interests and expertise in astrophysics, theoretical neuroscience, engineering, advanced mathematical & computational methods. I see myself as eventually leading such projects and training programs in areas at the intersection of these fields of knowledge.

CITIZENSHIP India

RESEARCH INTERESTS Theoretical neuroscience, Machine learning (deep learning & sparse coding), geometric signal processing & information theory, cosmology, network theory, radiative transfer, astrophysical simulations/theory,

## EDUCATION

### University of Groningen, Groningen, Netherlands

Ph.D., Kapteyn Astronomical Institute, March 2009

- Thesis Topic: *Cosmological Reionization Simulation for LOFAR*
- Thesis Proposal: *Developing fast reionization models*
- Adviser: Professor Saleem Zaroubi
- Area of Study: Theoretical Astrophysics

### Chalmers University, Gothenburg, Sweden

M.S., Earth and Space Sciences, March 2005

- Thesis Topic: *Detection of Planetary Transits using Wavelet Analysis and Genetic Algorithms*
- Adviser: Professor Sami Solanki, Max Planck Katlenburg.
- Area of Study: Astronomical Signal Processing

### Bangalore University, Bangalore, India

B.S., Electronics and Communication Engineering, June 2003

- *Magna cum Laude*, With Honors in Engineering
- Specialization: image analysis

## ACADEMIC APPOINTMENTS

- **Researcher** Jan 2012 to present  
Netherlands Institute for Neuroscience,  
Royal Netherlands Academy of Arts and Sciences
  - Information theory
  - Network analysis
  - Image processing & Statistical analysis

- **Postdoctoral Researcher** Jan 2010 to Jan 2012  
 Canadian Institute for Theoretical Astrophysics,  
 University of Toronto
  - Astrophysical simulations (ENZO, GADGET)
  - Recombination Physics
  - Radio Astronomical signal processing
- **Visiting Researcher** May 2009 to Jan 2010  
 Institute for the Physics and Mathematics of the Universe,  
 University of Tokyo
  - Radiative transfer
  - Cosmic magnetic fields

## PUBLICATIONS

- **Neuroscience**
  - [Increased functional connectivity between subcortical and cortical resting-state networks in autism spectrum disorder](#) , Cerliani L., **Thomas, R. M.**, Maarten Mennes., Adriana Di Martino., Marc Thioux., Christian Keysers., *2015, JAMA Psychiatry*
  - [Sparse coding with a global connectivity constraint](#); **Thomas, R. M.**, Keysers, C., Yatawatta, Sarod, *2014, ICIP*
  - [Large autism sample unravels hypo- and hyper-connectivity between functional networks at rest](#) ; Cerliani L., **Rajat M. Thomas**, Keysers C; *in prep*
  - [Functional Magnetic Resonance Imaging Connectivity Analyses Reveal Efference-Copy Signal to BA2](#); Cui et al., *2014, PLoS One*
  - [Gradual changes in the cortico-cortical connectivity of the human insula revealed by probabilistic tractography](#); Cerliani L., **Rajat M. Thomas**, Nanetti L., Siero J.C.W., Crippa A., Gazzola V., Keysers C; *2012, J.Human Brain Mapping*
- **Astrophysics**
  - [Constraining the epoch of reionization with the variance statistic: simulations of the LOFAR case](#); Patil, Ajinkya H.; Zaroubi, Saleem; Chapman, Emma; Jeli?, Vibor; Harker, Geraint; Abdalla, Filipe B.; Asad, Khan M. B.; Bernardi, Gianni; Brentjens, Michiel A.; de Bruyn, A. G.; Bus, Sander; Ciardi, Benedetta; Dai-boo, Soobash; Fernandez, Elizabeth R.; Ghosh, Abhik; Jensen, Hannes; Kazemi, Sanaz; Koopmans, Lon V. E.; Labropoulos, Panagiotis; Mevius, Maaijke; Martinez, Oscar; Mellema, Garrelt; Offringa, Andre. R.; Pandey, Vishhambhar N.; Schaye, Joop; **Thomas, Rajat M.**; Vedantham, Harish K.; Veligatla, Vamsikrishna; Wijnholds, Stefan J.; Yatawatta, Sarod, *2014, MNRAS*
  - [The Opacity of the Intergalactic Medium during Reionization: Resolving Small-scale Structure](#); Emberson, J. D., **Thomas, Rajat M.**, Alvarez, M.A., *2013, Astrophysical Journal*
  - [LOFAR insights into the epoch of reionization from the cross-power spectrum of 21 cm emission and galaxies](#); Wiersma, R. P. C, Ciardi, B., **Thomas, R. M.**, et al., *2013, MNRAS*

- Probing reionization with LOFAR using 21-cm redshift space distortions; Jensma et al., 2013, *MNRAS*
- Initial deep LOFAR observations of epoch of reionization windows. I. The north celestial pole; Yatawatta et al., 2013, *Astronomy & Astrophysics*
- Prospects for detecting the 21 cm forest from the diffuse intergalactic medium with LOFAR; Ciardi, B., Labropoulos, P., Maselli, A., **Thomas, R. M.**, et al., 2013, *MNRAS*
- Imaging neutral hydrogen on large scales during the Epoch of Reionization with LOFAR; Zaroubi, S., de Bruyn, A. G., Harker, G., **Thomas, R. M.**, et al., 2012, *MNRAS*
- Towards a complete treatment of the cosmological recombination problem; Chluba, J., **Thomas, R. M.**, 2010, *MNRAS*.
- The LOFAR EoR Data Model: (I) Effects of Noise and Instrumental Corruptions on the 21-cm Reionization Signal-Extraction Strategy; Labropoulos, Panagiotis, Koopmans, Leon V. E., Jelic, Vibor., Yatawatta, Sarod., **Thomas, Rajat M.**, Bernardi, Gianni., Brentjens, Michiel., de Bruyn, Ger., Ciardi, Benedetta., Harker, Geraint., Offringa, Andre., Pandey, Vishambar N., Schaye, Joop., Zaroubi, Saleem., 2010, *in prep*
- On the spin-temperature evolution during the epoch of reionization; **Thomas, Rajat M.**, and Zaroubi, Saleem., 2010, *MNRAS*.
- Power spectrum extraction for redshifted 21-cm Epoch of Reionization experiments: the LOFAR case; Harker, Geraint., Zaroubi, Saleem., Bernardi, Gianni., Brentjens, Michiel A., de Bruyn, A. G., Ciardi, Benedetta., Jeli, Vibor., Koopmans, Leon V. E., Labropoulos, Panagiotis., Mellema, Garrelt., Offringa, Andr., Pandey, V. N., Pawlik., Andreas H., Schaye, Joop, **Thomas, Rajat M.**, Yatawatta, Sarod, 2010, *MNRAS*.
- Cross-correlation study between the cosmological 21 cm signal and the kinetic Sunyaev-Zel'dovich effect; Jelic Vibor., Zaroubi, Saleem., Aghanim, Nabila, Douspis, Marian, Koopmans, Leon V. E., Langer, Mathieu, Mellema, Garrelt, Tashiro, Hiroyuki, **Thomas, Rajat M.**, 2010, *MNRAS*.
- Foregrounds for observations of the cosmological 21 cm line: II. Westerbork observations of the fields around 3C196 and the North Celestial Pole; Bernardi, G., de Bruyn, A. G., Harker, G., Brentjens, M. A., Ciardi, B., Jeli, V., Koopmans, L. V. E., Labropoulos, P., Offringa, A., Pandey, V. N., Schaye, J., **Thomas, R. M.**, Yatawatta, S., Zaroubi, S., 2010, *Astronomy and Astrophysics*.
- Non-parametric foreground subtraction for 21-cm epoch of reionization experiments; Harker, Geraint., Zaroubi, Saleem., Bernardi, Gianni., Brentjens, Michiel A., de Bruyn, A. G., Ciardi, Benedetta., Jelic, Vibor., Koopmans, Leon V. E., Labropoulos, Panagiotis, Mellema, Garrelt, Offringa, Andrie., Pandey, V. N., Schaye, Joop, **Thomas, Rajat M.**, & Yatawatta, Sarod., 2009, *MNRAS*.
- Foregrounds for observations of the cosmological 21 cm line. I. First Westerbork measurements of Galactic emission at 150 MHz in a low latitude field; Bernardi, G., de Bruyn, A. G., Brentjens, M. A., Ciardi, B., Harker, G., Jelic, V., Koopmans, L. V. E., Labropoulos, P., Offringa, A., Pandey, V. N., Schaye, J., **Thomas, R. M.**, Yatawatta, S., & Zaroubi, S., 2009, *Astronomy and Astrophysics*.

Detection and extraction of signals from the epoch of reionization using higher-order one-point statistics; Harker, Geraint J. A., Zaroubi, Saleem, **Thomas, Rajat M.**, Jelic, Vibor., Labropoulos, Panagiotis., Mellema, Garreлт., Iliev, Ilian T., Bernardi, Gianni., Brentjens, Michiel A., de Bruyn, A. G., Ciardi, Benedetta, Koopmans, Leon V. E., Pandey, V. N., Pawlik, Andreas H., Schaye, Joop., & Yatawatta, Sarod., 2009, *MNRAS*.

Fast large-scale reionization simulations; **Thomas, Rajat M.**, Zaroubi, Saleem., Ciardi, Benedetta., Pawlik, Andreas H., Labropoulos, Panagiotis., Jelic, Vibor., Bernardi, Gianni., Brentjens, Michiel A., de Bruyn, A. G., Harker, Geraint J. A., Koopmans, Leon V. E., Mellema, Garreлт., Pandey, V. N., Schaye, Joop., & Yatawatta, Sarod., 2009, *MNRAS*.

Foreground simulations for the LOFAR-epoch of reionization experiment; Jelic, V., Zaroubi, S., Labropoulos, P., **Thomas, R. M.**, Bernardi, G., Brentjens, M. A., de Bruyn, A. G., Ciardi, B., Harker, G., Koopmans, L. V. E., Pandey, V. N., Schaye, J., & Yatawatta, S., 2008, *MNRAS*.

Time-evolution of ionization and heating around first stars and miniquasars; **Thomas, Rajat M.** and Zaroubi, Saleem., 2008, *MNRAS*.

Heating of the intergalactic medium by primordial miniquasars; Zaroubi, Saleem, **Thomas, Rajat M.**, Sugiyama, N., & Silk, J., 2007, *MNRAS*.

#### CONFERENCE PUBLICATIONS

Trajectories of connectivity variation in the macaque insula recovered by means of probabilistic white matter tractography on diffusion-weighted magnetic resonance data.; Cerliani L., DArceuil H., **Rajat M. Thomas**, Keysers C. Poster presented at the Society for Neuroscience. meeting (sfn2009), October 21, 2009, Chicago IL.

Simulations of the 21(1+z) cm EoR signal; **Rajat M. Thomas.**, Saleem Zaroubi., *Far Away: Light in the Young Universe at Redshift beyond Three*, 7 - 11 July, Paris, France.

Simulations of the 21(1+z)cm EoR signal; **Rajat M. Thomas.**, Saleem Zaroubi., LOFAR TEAM, *Netherlands Astronomical Conference*, 7 - 9 May 2008, The Netherlands.

Signature of current sheets as seen by TIP at VTT in the HeI multiplet at 1083.0 nm; Regina A. C, Sami K. S, Andreas Lagg, **Rajat M. Thomas.**, *Conf. Coronal Heating* 6-9 Sept-2004, Univ. St. Andrews, UK.

#### GRANTS

- Co-PI: NWO ( A Dutch government funding) to study neuroanatomy of autism. Awarded ~ 0.3 Million Euros.
- Co-PI: Reionization Simulations for LOFAR. Awarded ~ 0.2 Million Euros.

#### CONFERENCE TALKS

- *At the interface of dynamical and statistical cosmology and transport optimization*, March 22-26, Haifa, Israel.
- *Science with e-LOFAR*, 16 - 20 September, Hamburg, Germany.
- *Far Away: Light in the Young Universe at Redshift beyond Three*, 7 - 11 July, Paris, France.
- *Astrophysics in the LOFAR era*, 23 - 27 April 2007, Emmen, The Netherlands.
- *From Strings to Cosmic Web*, 30-November to 2-December 2005, Groningen, The Netherlands.
- *Reionizing the Universe*, The Epoch of Reionization and the Physics of the IGM, 27-June to 1-July 2005, Groningen, The Netherlands.

REFEREE FOR  
JOURNALS  
AWARDS

- *Monthly Notices of the Royal Astronomical Society*
- *Ubbo Emmuis Scholarship* 2005 - 2009, University of Groningen.

SCHOOLS &  
WORKSHOPS

- *The Physics of the Intracluster Medium*, August 23-25, 2010, University of Michigan, Ann Arbor, U.S.A.
- *Statistical Frontiers of Astrophysics*, Sept 29 - Oct 3, IPMU, University of Tokyo, Japan.
- *dark energy: lighting up the darkness!*, June 22 - 26, IPMU, University of Tokyo, Japan.
- *Theoretical Neuroscience & Complex Systems*, 2 - 23 August 2008, PENS summer school, Frankfurt Institute of Advanced Studies, Germany.
- *Mathematics of Brain Imaging*, 14 - 25 July 2008, University of California, Los Angeles, U.S.A.
- *Netherlands Astronomical Conference*, 7 - 9 May 2008, The Netherlands.
- *MCCT Skads workshop*, 2 - 7 March 2008, University of Groningen, The Netherlands.
- *Radiative transfer workshop*, 3 - 7 September 2007, Durham, UK.
- *Summer School in Statistics for Astronomers III*, June 4-9 2007, PennState University, U.S.A.
- *"First Stars" workshop*, 16 - 20 April 2007, Copenhagen, Denmark.
- *MEQTREES Workshop*, Jan 30 - 2 February 2007, Dwingeloo, The Netherlands.
- *The NOVA Fall school 2007, Research topics on Galaxies*, 9 -13 October 2006, ASTRON-Dwingeloo, 2006.
- *36<sup>th</sup> Saas Fee School on "First Light in the Universe"*, March 2006, Les Diablalet, Switzerland.
- *Cosmological Radiative Transfer Comparison Project,workshop*, Lorentz Centre, 12 - 14 December 2005, Leiden, The Netherlands.
- *Summer School NOVICOSMO-2005, "The Dark And The Luminous Sides Of The Formation Of Structures"*, 5 - 17 September 2005,Novigrad-Croatia.
- *SKA workshop: Wide Field Imaging*, 22 - 24 June 2005, Dwingeloo, The Netherlands.

SCIENTIFIC VISITS

- *Max-Planck Institute for Astrophysics*, July, 2007.
- *Kavli Institute for Theoretical Physics*, March-April, 2010.

TEACHING  
EXPERIENCE

**University of Toronto**, Toronto, Ontario, Canada

- *Instructor* **November 2010 to December 2010**  
(sample graded material and student evaluations available upon request)
  - *Insights into Statistics*, A specialized course for graduate students in astronomy and astrophysics.

**Kapteyn Astronomical Institute**, Groningen, The Netherlands

- *Instructor* **October 2008 & 2009**
  - *Signal Processing for astronomy*, A series of lectures in a graduate level course introducing multi-resolution analysis.

**Max Planck Institute for Solar System Research**, Katlenburg-Lindau, Germany

- *Instructor* **July 2004**

- *Mathematics of wavelet theory*, A tutorial for the staff, postdocs and graduate students of the institute.

#### SUPERVISION

- Co-supervising (with Chris Matzner) *Etsuko Meida* on a PhD project, *Formation of PopIII stars.*, current.
- Co-supervised (with Saleem Zaroubi) *Jouke Jensma* on a MSc project, *Spin temperature evolution during reionization*, 2010.
- Co-supervised (with Saleem Zaroubi) *Gijs de Goeijn* on a BSc project, *Point-process based reionization calculation.*, 2009.

#### SERVICE

- Designed science exhibits at the Planetarium in Bangalore, India, as part of the Bangalore Association for Science Education
- Designed and conducted a prestigious science quiz at the Indian Institute of Science.

#### TECHNICAL SKILLS Extensive software experience in scientific simulations

Building Packages: Designed and built state-of-the-art radiative transfer packages STAR-DUST and BEARS in ANSI-C.

Programming: C, C++, MATLAB, UNIX (10+ years), R, Python, (1+ years), IDL

MATLAB experience: linear algebra, Fourier transforms, nonlinear numerical methods, polynomials, statistics,

Operating Systems: Linux, Apple OS X, Microsoft Windows, BSD, and other UNIX variants

#### PHYSICS

Cosmology, Radiative Transfer, Thermodynamics, Non-linearity/Chaos

#### EXPERTISE

#### MATHEMATICAL EXPERTISE

Differential equations, Complex Analysis, Fourier Analysis, Differential Geometry, Linear Algebra

#### ENGINEERING EXPERTISE

Communications and Signal Processing: Fourier transforms, Wavelet analysis, Probability, Random Variables, Stochastic Processes, Estimation, Networks

#### APPLICATION AREAS

Numerical Astrophysics, Signal processing / Deconvolution, Diffusion tensor imaging, Complex systems, Time-series analysis

#### REFERENCES

- **Astrophysics**

##### **Prof. Saleem Zaroubi**

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Groningen, The Netherlands  
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##### **Prof. Leon Koopmans**

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- **Neuroscience**

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