Niraj N Lal

Dr Niraj N Lal BSc (ANU), PhD (Cambridge) Curriculum Vitae

Research Fellow, Monash University Renewable Energy Laboratory,

Visiting Scientist CSIRO | Visiting Fellow, Centre for Sustainable Energy Systems, ANU

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Education

2009 – 2012: University of Cambridge, England, PhD in Physics, Cavendish Laboratory, (Gates Scholar)

2002 – 2007: Australian National University, Bachelor of Science (Hons Ia), (Distinguished Scholar Program)

Professional Experience

March 2016 – current OCE Science Team Leader Postdoctoral Researcher, Monash University and CSIRO

This position involves researching, developing and communicating advanced photovoltaic technologies.

My key duties include:

- Coordinating researchers as lead author to write an invited 10,000 word review for the respected international journal Advanced Energy Materials on "Perovskite tandem solar cells" - widely believed to be the photovoltaic technology of choice for the medium to long-term future.
- Lead researcher of multiple energy projects including: novel photoluminescence mapping techniques for rapid characterisation of next-generation solar cells and optoelectronic modelling of microstructured devices.
- Supervision and mentoring of 2 PhD students, providing feedback and assisting them to identify and overcome challenges in their research.
- Guest lecturer for the Monash University Materials and Technologies for Energy 4th year/Masters Course.
- Liasing with collaborators both in Australia and internationally, internal and external to research environments. Supporting my supervisor and broader research team in writing grant applications and presenting scientific outcomes to general audiences.

In addition to these formal duties, I also am

- an Academic mentor for solar energy projects for Engineers without Borders students, including the development and installation of small solar energy systems for rural Cambodia.
- Visiting Scientist at CSIRO Clayton
- Visiting Fellow with the Centre for Sustainable Energy Systems at the Australian National University

January 2014 - March 2016 Australian National University Lecturer of 'Renewable Energy Technologies'

This course is the core subject of the ANU 4th Year Engineering Sustainability Major and ANU Master of Energy Change course.

I wrote and delivered lectures covering:

- The breadth of current and emerging energy generation technologies, present status and future trends
- The developing local electricity storage industry, including battery storage and off-river pumped hydro
- solar and wind forecasting and the integration of intermittent energy sources into the grid
- energy pricing, smart metering and power-purchase agreements for renewables.
- technologies to integrate distributed electricity with the National Electricity Market..

- effective policy measures to facilitate the transition towards high penetration of renewables

As course convenor I assessed and provided feedback for close to two hundred projects on new energy technologies including many associated with the ACT's transition towards 100% Renewable Energy by 2020. These included projects on issues such as Reverse Auctions, Electric Vehicle and Battery Integration, Market Mechanisms for Pricing Auxiliary Power, Peer to Peer Electricity Trading, and appropriate government regulations and policies to aid the broader energy transition. With the assistance of a tutor, I coordinated the assessment of their written work, presentations and examinations.

I received 4.6/5 for 'overall effectiveness of lecturing', achieving the highest course satisfaction (88%) in 5 years in my first year of lecturing the course.

October 2012 – March 2016: Australian Renewable Energy Agency Postdoctoral Research Fellow; **Australian National University**

I secured successful funding for three years from ARENA to investigate novel concepts in light-trapping for advanced photovoltaic technologies. In addition to publication of six high-impact articles in peer-reviewed international journals, I supervised 3 honours students to successful graduation. In 2013 I was named the ACT Young Tall Poppy of the Year by the Australian Institute of Policy and Science, which led to a number of opportunities to present about the fundamental structural changes occurring in the energy systems across the world.

Alongside my research activities, I was an invited guest lecturer with the ANU Energy Change Institute, and in 2014 was elected as an Early Career Academic Fellow and Honorary Member of University House.

2009 – 2012: Cavendish Laboratory, University of Cambridge, UK. PhD in Physics. , **Gates Scholarship Theme:**

Thesis: 'Enhancing solar cells with plasmonic nanovoids' – shortlisted for the Salje Medal 2012,

Modelling, fabrication and characterisation of advanced optics for high-efficiency solar cells.

Invited lecturer to speak on Energy Technologies for the Cambridge International Summer Schools, Cambridge Mature Education and Widening Participation programs. My research output and outreach activities led me to being one of five scholars featured in the 10 year anniversary movie of the Gates Cambridge Scholarship.

Physics supervisor - Cambridge University, University of Western Australia, Australian National University

Supervising, demonstrating and tutoring the Cambridge Natural Sciences Tripos Part Ia and Part III MPhil (physics), and 1st-3rd year physics at UWA and ANU, 2006-12.

Additional Professional Experience

2009 – 2016 Director, **First Principles Consulting**

In my role as Director I:

- consulted in science communication for Screentime Australia, ABC Television, ABC Radio, ABC Science Online, and managed projects of over $50k for Newcastle Museum
- Managed multiple grants and funding for science communication and energy consulting, including multiple National Science Week Grants
- Delivered invited lectures with the ANU Energy Change Institute to the Australian Defence Force

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2015 – 2016:

- ANU University Early Career Academic Fellow
- Honorary Member University House, Australian National University 2015-16;
- Reviewer for numerous international academic journals

Awards (selected) - total awarded grants, prizes and scholarships: AUD $550,000

ABC Top 5 Under 40 Scientist, 2016;

ACT Ambassador for National Science Week 2016

Australian Academy of Science Nominee to the 2015 Nobel Laureates meeting in Lindau, Germany

Australian Institute of Physics Science Meets Parliament Delegate 2014

Honorary Membership of University House, University Early Career Academic Fellowship, ANU, 2015-17;

2013 ACT Young Tall Poppy of the Year, awarded by the Australian Institute for Policy and Science;

Student Research Prize and honorarium, ₩770,000 (~AUD$650) 5th International Conference on Surface Plasmon Photonics, Busan, Korea, May, 2011;

BBC Radio Naked Scientists show and online author 2010

University Medal for the Young Tall Poppy of the Year, Australian National University; 2013

Invited Presentation, Optics Society of America Annual Congress, Karlsruhe, Germany, June, 2010;

Australian National Science Week Seed Grants for science outreach to high-schools; $2600, 2013, 14,

Gates Cambridge Scholarship, international full-cost scholarships to study at the University of Cambridge, awarded for 'intellectual ability, leadership capacity and the desire to use knowledge to contribute to society', GBP £40,000, 2009-12,

Professional activities

ANU University Early Career Academic Fellow 2015-16,

Honorary Member University House, Australian National University 2015-16;

Cavendish Graduate Student Committee 2009-2011;

President, Australian National University Physics Students Society, 2003;

Founder Cavendish Laboratory Purple Shin Football Competition 2009-12

Member: Australian Institute of Physics, International Solar Energy Society, Australian Science Communicators

Reviewer for: Energy and Environ. Sci. (15.49)*, J. Phys Chem Lett (8.539), Progress in Photovoltaics (7.584), J. Mat Chem (6.626), Scientific Reports (5.578), Solar Energy Mat. and Solar Cells (5.030), Phys. Chem. Chem. Phys. (4.198), Appl. Phys. Lett. (3.794), Phys Rev B, (3.718), Opt. Exp. (3.525), J. Select Topics in Quantum Electronics (3.465), Nanoscale Res. Lett. (2.418) and J. Appl. Phys. (2.185). (Note: ()* indicates the impact factor of the journal in 2016.)

Additional qualifications and extra-curricular activities

ACT Rural Fire Service Bush Firefighter, Rivers Brigade 2013-current; (PUAOHS001A, PUAFIR201A, PUAOPE013A, PUATEA001A, PUATEA004A, PUAFIR204A, PUAEQU001B)

Senior First Aid Certificate, Parasol (HLTFA311A) 2013-current; Advanced PADI open-water diver 2005-current;

4WD Training, Adventure 4WD, Perth, Western Australia

Working with Children Check ACT, 2012-current | State Emergency Services Volunteer, Rivers Brigade ACT, 2003-4;

Research Highlights:

Dr Niraj Lal has two invited presentations at international conferences (Optics Society of America Annual Congress 2010, 5th International Conference on Surface Plasmon Photonics 2011), and his first-author publications include articles in the world's leading condensed matter physics journal (N. Lal, Phys Rev. B. 85 (24), 2012, cited 27 times), highly cited work on solar cell plasmonics (N. Lal, Opt Exp. 19 (12), 2011, cited 64 times), and recent research on perovskite-silicon tandem solar cells (N. Lal, IEEE J. Photovoltaics 4 (6), Nov 2014, the journal's 2nd most downloaded paper in the three months following publication (670 downloads)).

Dr Lal's total FTE since graduation from his PhD is 2 years and 10 months.

Referees

A/Prof Kylie Catchpole,
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Dr Niraj Lal, Selected Research Publications

Metrics: 14 published journal articles, >250 citations to date, 7 lead author conference presentations, 2 invited international conference presentations, H-index of 9.

A: Refereed Journal articles

1. **N. N. Lal,** Y. Dkhissi, W. Lei, Q. Hou and U. Bach, "Perovskite tandem solar cells" Invited Progress Report, Advanced Energy Materials, *submitted*

2. **N. N. Lal,** K.F. Le, A. Thomson, M. Brauers, T. P. White, and K. R. Catchpole, "Transparent long-pass filter with short-wavelength scattering based on Morpho butterfly nanostructures", ACS Photonics, *submitted*

3.. B. W. Schneider, **N. N. Lal**, S. Baker-Finch, and T. P. White, "Pyramidal surface textures for antireflection and light trapping in perovskite-on-silicon tandem solar cells,"Optics Express 22, 6, 2014;

4. T. P. White, **N. N. Lal**, and K. R. Catchpole, "Tandem Solar Cells Based on High-Efficiency c-Si Bottom Cells: Top Cell Requirements for > 30 % Efficiency" IEEE Journal of Photovoltaics 4, 208, 2014;

5. **N. N. Lal**, H. Zhou, J. K. Sinha, M. Hawkeye, P. N. Bartlett, G. A. J. Amaratunga, and J. J. Baumberg, "Using spacer layers to control metal and semiconductor absorption in ultrathin solar cells with plasmonic substrates", Physical Review B 85, 245318, 2012;

6. A.F. Thomson, **N. N. Lal,** Y. Wan, "Interpolating the optical properties of varied composition silicon nitride", Physica Status Solidi b, 1(6), 2015;

7. **N. N. Lal,** B. F. Soares, J. K. Sinha, F. Huang, S. Mahajan, P. N. Bartlett, N. C. Greenham, and J. J. Baumberg, "Enhancing solar cells with localized plasmons in nanovoids", Optics Express 19 (12), 3918, 2011;

8. T. S. Gershon, **N. N. Lal**, J. J. Baumberg, and J. L. MacManus-Driscoll, "Tuneable Mie-scattering from electrodeposited Cu2O nanoparticles", Journal of the Electrochemistry Society 159 (12), D747, 2012;

9. **N.N. Lal** and A.W. Blakers 'Sliver Cells in Thermophotovoltaic Systems', Solar Energy Materials and Solar Cells 93, 167, 2009;

10. H. Butt, Q. Dai, **N. N. Lal**, T. D. Wilkinson, J. J. Baumberg, and G. A. J. Amaratunga, "Metamaterial filter for the near-visible spectrum", Applied Physics Letters 101, 083106, 2012;

11. P. Hiralal, C. Chien, **N.N. Lal**, H. Butt, H. Zhou, H.E. Unalan, J.J. Baumberg, G.A.J. Amaratunga, "Nanowire-based Multifunctional Antireflection coatings for Solar cells", Nano Letters, submitted

12. R. B. Dunbar, T. Pfadler, **N. N. Lal**, J. J. Baumberg, and L. Schmidt- Mende, "Imprinting localized plasmons for enhanced solar cells", Nanotechnology 23, 385202, 2012;

13. J. D. Speed, R. P. Johnson, J. T. Hugall, **N. N. Lal**, P. N. Bartlett, J. J. Baumberg, and A. E. Russell, "SERS from molecules bridging the gap of particle-in-cavity structures", Chemical Communications 47, 6335, 2011.

B. Conference presentations (*indicates conference presenter)

N.N. Lal*, T.P. White, K.R. Catchpole, Photonics West, San Francisco 2014,

N.N. Lal*, B.F. Soares, J.K. Sinha, S. Mahajan, P.N. Bartlett, N.C. Greenham, F.G. de Abajo, J. J. Baumberg, 5th International Conference on Surface Plasmon Photonics, Korea 2011, **invited** oral presentation

N.N. Lal*, B.F. Soares, J.K. Sinha, S. Mahajan, P.N. Bartlett, N.C. Greenham, F.G. de Abajo, J. J. Baumberg, Optics Society of America Congress 2010, Karlsruhe, Germany, **invited** oral presentation

N.N. Lal, F. Huang* B.F. Soares, J.K. Sinha, S. Mahajan, P.N. Bartlett, N.C. Greenham, F.G. de Abajo, J. J. Baumberg, CLEO, Baltimore, USA, 2011, oral presentation

N.N. Lal*, F. Huang B.F. Soares, J.K. Sinha, S. Mahajan, P.N. Bartlett, N.C. Greenham, F.G. de Abajo, J. J. Baumberg, UK Solar Energy Society Conference, Edinburgh, Scotland, 2011, oral presentation

N.N. Lal, G.P.R.M Christmann*, F. Huang, B.F. Soares, J.K. Sinha, S. Mahajan, P.N. Bartlett, N.C. Greenham, J. J. Baumberg, CLEO, San Jose, USA, 2010, oral presentation

N.N. Lal* and A.W. Blakers, 45th annual ANZSES conference, Alice Springs, Australia, 2007, oral presentation.

C. Other publications

N.N. Lal, T.P. White, K.R. Catchpole, "Plasmonic and dielectric enhancement of solar cells", SPIE Newsroom, 2013

N.N. Lal "Noise vs Signal" Foundation for action against bulk surveillance, Pilularis Press, July 2014

N.N. Lal "Triple bottom line academia: communicating in the face of research cuts", Pilularis Press, July 2014

N.N. Lal, "Catching energy from the sun", BBC Radio Naked Scientists Article online, on How Solar Cells Work, 2010,

N.N. Lal "Wikileaks, with images from Banksy", Pilularis Press, September 2013

N.N. Lal, "Finding the right energy level", British Science Association Quarterly, through the University of Cambridge Rising Stars Program, December 2010,

N.N. Lal, A.W. Blakers, "Sliver cells in thermophotovoltaic systems", SPIE Newsroom, 2009

N.N. Lal "The greatest threat to democracy", on electronic voting in Australia, Gadabout Press 2013

N.N. Lal, "Butterfly Flo and the Everything Effect", children's story on a butterfly in the Australian bush who learns about the Butterfly Effect of chaos theory, in submission, Allen & Unwin Publishing House, 2013

D. Feedback

Lecturing

Student evaluation: ENGN4516/6516 Renewable Energy Technologies (3rd year/Masters)

Overall experience of lecturing: **4.6/5:** Anonymous official feedback: *"An impressive lecturer with a lot of energy for his work and an ability to understand and communicate the bigger picture", "Interested and engaging.", "Informed and made the lectures fun", "Captivating to listen to…" "An incredible lecturer" "A great lecturer. One of the best courses I have done while at uni". "Charismatic and used humour to good effect". "Nij made learning fun"*

Dr Lal achieved the highest student satisfaction (**88%**) in 5 years in the first year taking over the course.

Consulting

"Dr Lal brought a wonderful combination of science smarts and engaging enthusiasm to his work and successfully completed all the tasks required in his scope of works. His experience in the whole process of research, development and delivery… ensured he could work independently and deliver off-the-shelf quality products. He is professional, reliable and totally fun to work with. Whether engaging with teachers, sponsors or little five year olds, Niraj was able to establish a positive rapport."
- Sam Wilcox, Public Programs Manager, Newcastle Museum

"Dr Lal delivered an exciting lecture on energy fundamentals. Particularly impressive were his demonstrations, and explanations that were both lucid and scientifically strong.
- Dr Igor Skryabin, Course Convenor for the ANU Professional Short Course on Energy Change to the Australian Defence Force and the Federal Department of Defence.

Communication

"Nij is amazing at outreach… he makes even hardcore physics sound like fun!"
- Sue Long, Outreach Officer, University of Cambridge

"He had all the students rapt - his lively presentation style and the many gadgets clearly got them all hooked. He had sound, flames, electricity, and juggling all in one show - and the students paid close attention. I wish I had all the energy that Nij brings to his show."
- Professor Hans Bachor, OA FAA, College of Physics, Australian National University

"Niraj is a gifted writer of children's stories. His latest story, about an emu that wanted to fly, brings real depth of science to a lovely story. This is Isaac Newton's story of the apple falling on his head rewritten – great for all ages!"
- Sir Richard Friend FRS, Cavendish Professor of Physics, University of Cambridge