



The George Szekeres Medal  
2020

**Nalini Joshi**

Nalini Joshi AO, Payne-Scott Professor and Chair of Applied Mathematics at the University of Sydney, is a world leader in the theory and applications of differential equations, contributing mathematical results that have impact in fields as diverse as particle physics, quantum mechanics, large prime-number distributions, and wireless communications. Her distinguished research record has brought numerous awards including becoming the 150th Anniversary Hardy Fellow of the London Mathematical Society in 2015.

Nalini's contribution to the Australian and international mathematical community is outstanding. She served as Head of School of Mathematics and Statistics, University of Sydney (2007–10), as Chair of the Australian Council of Heads of Mathematical Sciences (2008), as President of AustMS (2008–10), as a Board member of the Australian Mathematics Trust (2010–12), as Chair of the IMU/ICIAM Working Group on Journal Rankings (2010–12), as Chair of the National Committee for Mathematical Sciences for the Australian Academy of Science (AAS) (2011–16), as a key player in development of the Decadal Plan for Mathematical Sciences, as a Member of the Council of the AAS (2012–15), as a Member of the IMU Working group on Women in Mathematics (2013–14), as Co-Chair of the Science in Australia Gender Equity (SAGE) Initiative (2013–16), as a Member of the Prime Minister's Commonwealth Science Council (2014–), as a Member of the Science in Australia Gender Equity Expert Advisory Group (2016–), and is currently the first Australian Vice President of the International Mathematical Union (2019–2022). She was the first mathematician to be awarded a Georgina Sweet ARC Laureate Fellowship (2012–2016). Nalini promotes mathematics to government and the wider community, and her work on creation of the SAGE initiative has resulted in influential actions and impact across the nation.

## Extended citation

Nalini is a world leader in the theory and applications of differential equations, contributing mathematical results that underlie models of the effects of random behaviour in fields as diverse as particle physics, quantum mechanics, large prime-number distributions, and wireless communications. Furthermore, she has made significant contributions to the mathematics community, including in leadership, gender equity, and promotion of mathematics.

## Research Achievements and Standing

Classical mathematical modelling typically relies on linear models, but much of the world is not linear; examples include water waves in the ocean and the fluctuations of infected cells in the bloodstream. Prediction of such nonlinear systems is necessary for understanding and controlling our world, but the difficulty of prediction is compounded by singularities, similar to shock waves, where functions become immeasurable. There is a dearth of existing tools for describing such nonlinear singular systems and Nalini has pioneered innovative methodologies in mathematics for describing these, with a particular focus on integrable systems such as the Painlevé equations. Her deep understanding of nonlinear systems has enabled her to develop simple, precise definitions of functions, yielding descriptions that extend to the whole domain of existence. They relate behaviours before and after a critical transition-point in applications such as quantum tunnelling, spontaneous magnetisation in metals, and water waves with surface tension. Nalini's research includes Riemann–Hilbert theory, asymptotics and approximation theory, exponential asymptotics, and geometry of dynamical systems. Her new methodologies have uncovered hidden information across multiple fields and sparked significant new research programs across the globe. Nalini has written over 100 peer-reviewed papers together with authored and edited monographs. Her outstanding contribution to mathematics is confirmed by numerous awards and positions which include:

- Fellowship of the Australian Academy of Sciences (elected 2008);
- Council member of the Australian Academy of Sciences 2012–15;
- Fellow of the Royal Society of NSW from 2014;
- The London Mathematical Society's Hardy Fellowship in 2015 (Fields medallist Terry Tao is the only other Australian to receive this fellowship);
- US Conference Board of Mathematical Sciences and NSF Mathematical Sciences Lecturer in 2016;
- Officer of the Order of Australia in 2016 "for distinguished service to mathematical science and tertiary education as an academic, author and researcher, to professional societies, and as a role model and mentor of young mathematicians".
- Bragg Fellowship at the Royal Institution of Australia in 2019, recognising "excellence in scientific achievement and commitment to science in Australia";
- Head of the School of Mathematics and Statistics, University of Sydney 2007–10;
- President of AustMS 2008–10;
- Vice-President of the International Mathematics Union 2019–22;
- 2019 UCLA Distinguished Lecturer;
- The 2019 NSW Premier's Prize for Excellence in Mathematics, Chemistry, Physics and Geosciences.
- Georgina Sweet Laureate Fellowship 2012 (first mathematician to receive such).

Nalini's subject area is one where citations are acquired gradually and over an extended period. On Scopus (May 2020) she has acquired 50–90 cites a year since 2015 and her total citation count is 1151. Her *h*-index is impressive (18) which demonstrates major impact of her work. She has attracted a total research income approaching \$6 million and has held two major fellowships via the ARC, including a Georgina Sweet Laureate Fellowship. Nalini is often invited as principal speaker for prominent overseas mathematical associations. She sits on the editorial boards of four international journals, has served on the ARC Selection Advisory Committee and been Co-Chair of the ARC Future Fellowships panel. She has been an international member of the expert panel for the UK EPSRC, and served on the advisory boards of the Banff International Research Station, AMSI and the Australian Academy of Science Council.

### **Leadership, Gender Equity, and Promotion of Mathematics**

Nalini has served as Head of the School of Mathematics and Statistics at the University of Sydney (2007–10), and as President of the Australian Mathematical Society (2008–10). She has mentored 24 postdoctoral research fellows, 15 PhD students and 13 Honours students. Her leadership is recognised both in Australia and internationally, and she is currently the Vice-President of the International Mathematical Union (2019–2022). In addition to her research contributions and leadership roles, Nalini has worked tirelessly to promote mathematics to the wider scientific community and general public. She was instrumental in development of the Decadal Plan for Mathematical Sciences. She has been a panellist on the ABC's Q&A and is frequently interviewed on mathematics education both online and on the radio. As mentioned above, her appointment as an officer of the Order of Australia in 2016 was "for distinguished service to mathematical science and tertiary education as an academic, author and researcher, to professional societies, and as a role model and mentor of young mathematicians." In 2018, Nalini was awarded the Eureka prize for Outstanding Mentor of Young Researchers.

Nalini is especially famous for creating new ways to encourage, support and retain women in STEM careers. Her work on diversity, including the creation of the Science in Australia Gender Equity (SAGE) initiative, has resulted in influential actions and impact across the nation, making her an extremely powerful role model and mentor for young (female) mathematicians. She used her Georgina Sweet Laureate Fellowship to initiate and support, over five years, activities such as the Women in Mathematics Dinners/Lunches at the annual AustMS/ANZIAM conferences. The value of such events — raising awareness, providing support and networking opportunities, strengthening a sense of community — cannot be underestimated. Since 2017, she has co-organised annually the week-long Mentoring and Guidance in Career (MAGIC) program for female Early Career Researchers in mathematics and physics. She is an Ambassador of the IMU Committee for Women in Mathematics (CWM), a role she has held for some years.

In conclusion, Nalini is probably the highest profile mathematician in the region who is currently informing the public and government of the importance of mathematics both in schools and universities. She combines this with a sustained distinguished research record and numerous prestigious awards in recognition of her remarkable achievements. She is an excellent role model. For these reasons she is an exceptionally worthy recipient of the 2020 George Szekeres Medal.