2018 King Faisal International Prize Awarded to John Macleod Ball

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The King Faisal Foundation in Riyadh, Saudi Arabia has awarded the 2018 *King Faisal International Prize* (KFIP) for *Science* to Sir John Macleod Ball of the UK for his fundamental contributions to nonlinear partial differential equations, the calculus of variations, and applications to materials science and liquid crystals. The prize consists of a certificate, hand-written in Diwani calligraphy, summarising the laureate's work; a commemorative 24 carat, 200 gram gold medal, uniquely cast for each Prize; and a cash endowment of Saudi Riyal 750,000 (about US$200,000). The award ceremony took place on Monday, March 26, 2018 under the auspices of the King of Saudi Arabia [1].

Sir John Macleod Ball

John Macleod Ball was born on May 19, 1948 in Farnham, Surrey, UK. He obtained his undergraduate degree in Mathematics from St John's College at the University of Cambridge in 1969. He completed his PhD in Mechanical Engineering in 1972 at the School of Applied Sciences at the University of Sussex, Brighton under the supervision of David Edmunds. In 1972, he joined the Department of Mathematics, Heriot-Watt University on a SRC (Science Research Council, UK) postdoctoral fellowship. This fellowship enabled him to have extended visits to the Lefschetz Center for Dynamical Systems at Brown University, USA. At Brown University, he started to work on the "existence of solutions to the equilibrium equations of nonlinear elasticity", and "infinite-dimensional dynamical systems". He then received the SERC (Science and Engineering Research Council, UK) Senior Fellowship for the period 1980–1985. He held numerous visiting professorships including: Laboratoire d'Analyse Numérique, Université Pierre et Marie Curie, Paris, France (1994); Tata Institute of Fundamental Research, Bangalore centre, India (2001); and Institute for Advanced Study, Princeton, USA (2002–2003). He was elected a Fellow of the Royal Society of Edinburgh in 1980 at the age of 32, a Fellow of the Royal Society, UK in 1989, and an Associé Etranger of the Académie des Sciences, France in 2000.

John Ball is a leading figure in the international mathematical community. He held numerous positions including: Council Member of the EPSRC (Engineering and Physical Sciences Research Council, UK) during 1994–1999; President of the Edinburgh Mathematical Society during 1989–1990; and President of the London Mathematical Society

during 1996–1998. He is a founding member of the International Centre for Mathematical Sciences, Edinburgh, UK (in 1990). He was also involved in the establishment of the Institute for Mathematical Sciences in Scotland (in 2005). He was the President of the International Mathematical Union during 2003–2006. He has served on several award committees including: the first Abel Prize in 2002; and the Fields Medal in 1998 and 2006; Leelavati Prize (sponsored by Infosys) in 2010. He is also involved in the support for Mathematics in developing countries. Currently, he is the Sedleian Professor of Natural Philosophy, University of Oxford, UK and Director of the Oxford Centre for Nonlinear Partial Differential Equations.

As an anecdote, we note that John Ball had specially travelled to St Petersburg, Russia to convince the renowned mathematician Grigori Perelman (who had proved the Poincaré conjecture) to accept the Fields Medal in 2006 [2–3]. At that time John Ball was in his fourth and final year as the President of the International Mathematical Union. Perelman stuck to his decision to decline! According to the *Mathematics Genealogy Project*, John Ball's genealogy can be traced to Isaac Newton and Galileo Galilei [4]; the same is true for the present author! John Ball has an Erdős Number of 3 through Bernd Kirchheim and David Preiss [5].

John Ball's main research areas are nonlinear partial differential equations, calculus of variations, infinite-dimensional dynamical systems and their applications to nonlinear mechanics, and the mathematics of liquid crystals. In 1977, John Ball introduced the notion of polyconvexity and proved the existence of an equilibrium state (to be understood as a minimiser of the total energy function) for hyperplastic materials whose stored energy function is polyconvex, subjected to conservative applied forces [6]. To date, there are only two existence theorems in nonlinear elasticity. The first one (dating back to the 19th century) is based on the implicit function theorem whereas the one due to John Ball is based on the minimisation of the total energy [7]. In 1982, John Ball investigated discontinuous equilibrium solutions and cavitation in non-linear elasticity by modelling the appearance of a cavity in the interior of a solid, homogeneous, isotropic, hyperelastic body once a critical load is reached. This work using the mathematical concepts of singular solutions, weak solutions, energy-minimisers and Lyapunov functions formed the basis of extensive studies in nucleation and growth in such bodies [8]. He introduced novel methodologies for analysing the long-time asymptotic behaviour of solutions of nonlinear partial differential equations and the existence of corresponding global attractors. In recent years, he has made significant contributions to the mathematical understanding of the Landau–de Gennes theory of liquid crystals. Liquid crystals (widely used in electronic displays) are a class of soft matter systems that exhibit properties intermediate to solid crystals and isotropic fluids and hence are very challenging for a mathematical analysis. Pierre-Gilles de Gennes received the 1991 Nobel Prize in Physics for his work related to liquid crystals [9–10]. John Ball with Apala Majumdar introduced a singular potential, which is an alternative to the commonly used Landau–de Gennes bulk potential [11]. John Ball and Arghir Dani Zarnescu have worked on the orientability and energy minimisation in liquid crystal models [12]. John Ball and Richard D James have developed a theory that leads to a new understanding of the classical crystallographic theory of martensite, enabling new ways of viewing at shape memory alloys, hysteresis in solid phase transformations, magnetostrictive materials, and more generally the passage from microscales to macroscales in material science [13]. John Ball is a recipient of several awards including the Whittaker Prize (1981), Junior Whitehead Prize (1982), Sylvester Medal (2009), and Medal of the Royal Society of Edinburgh (2006). John Ball was the inaugural recipient of the David Crighton Medal (2003), awarded jointly by the Institute of Mathematics and its Applications (IMA) in Essex, UK, and the London Mathematical Society. He was knighted in 2006. An event titled "Workshop on Geometric Analysis, Elasticity, and PDEs, on the 60th Birthday of John Ball" was held at Maxwell Institute, Edinburgh, Scotland during June 23–27, 2008. Another event titled, "Mathematics and Science: In Honour of Sir John Ball" took place at Mathematical Institute, Oxford, UK during May 17–19, 2018, which attracted numerous renowned mathematicians [14].

The prizes are named after the third king of Saudi Arabia, to recognise dedicated men and women whose contributions make a positive difference, including scientists and scholars whose research result in significant advances in specific areas that benefit humanity. The *King Faisal Foundation* each year awards International Prizes (KFIP) for *Service to Islam*, *Islamic Studies*, *Arabic Literature*, *Medicine*,

and *Science*. The *science* subcategories cover a broad scope: *physics*; *mathematics*; *chemistry*; and *biology* by rotation cycle of four years [15–17]. Over 40 years (1979–2018), there have been 258 laureates from 43 nations. Out of 113 KFIP science and medicine laureates, 20 are Nobel laureates. A total of 57 scholars from 13 countries have been awarded the King Faisal International Prize for Science. The previous winners for Mathematics according to year are — 1987: Sir Michael Francis Atiyah (USA); 1991: (*Prize Withheld*); 1994: Dennis Parnell Sullivan (USA); 1998: Sir Andrew John Wiles (UK); 2002: Yuri Ivanovitch Manin (Russia) and Peter Williston Shor (USA); 2006: Mudumbai Seshachalu Narasimhan (India) and Sir Simon Kirwan Donaldson (UK); 2010: Enrico Bombieri (Italy) and Terence Chi-Shen Tao (Australia); and 2014: Gerd Faltings (Germany). Five of them have received the Fields Medal: Sir Michael Francis Atiyah (1966); Sir Simon Kirwan Donaldson (1986); Terence Chi-Shen Tao (2006); Enrico Bombieri (1974); and Gerd Faltings (1986) [17]. Two have received the Abel Prize: Sir Michael Francis Atiyah (2004) and Sir Andrew John Wiles (2016). Two have received the Wolf Prize in Mathematics: Sir Andrew John Wiles (1979) and Dennis Parnell Sullivan (2010). Two KFIP Laureates have received the *Breakthrough Prize in Mathematics*: Simon Donaldson (2014); and Terence Chi-Shen Tao (2014). Mudumbai Seshachalu Narasimhan is the only Asian to have won the KFIP for mathematics (in 2006) [18–19]. There are four women among the 113 KFIP science/medicine laureates (3.53%). There are 20 women among the 607 Nobel medicine/physics/chemistry laureates (3.29%). There is only one woman among the 60 Fields Medallists (1.66%) and she is Maryam Mirzakhani [20–21].

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