RICHARD V. E. LOVELACE

Richard Van Evera Lovelace (Born 16 October 1941) is an American astrophysicist and plasma physicist. Lovelace is the best known for discovery of period of pulsar in Crab Nebula, which helped to proof that pulsars are rotating neutron stars, for developing a magnetic model of jects from galaxies, for developing a model of Rossby waves in accretion disks, and for developing a model of ion rings. He organized the US-Russia collaboration in Plasma Astrophysics, which obtained many pioneering results in numerical modeling of magnetized stars.

Early life

Lovelace was born in Saint Louis on October 16, 1941. His father, Eldridge Lovelace, was a city planner, and had frequent travels to cities in the US and abroad. He often took his family with him, and Richard visited many places in the US and other countries during his young age. Father was also a specialist in parks and an artist, so that they visited many parks, museums and art galleries.

Richard went to John Burroughss school, where he has shown an extraordinary talent in physics and math. He collected in a home lab different electronic equipment, and developed radios, etc. He was interested in the space program. In 1957, he observed the Soviet Sputnik, passing over St. Louis, and together with parents, he went to first launches of American spacecrafts to Florida.

Education

He attended the Carnegie Tech and Washington University (St. Louis), and in 1964 he received the Bachelor degree from Washington University. He was a graduate student at Cornell University, and obtained PhD in Physics in 1970 working under E. E. Salpeter. Being a graduate student, he went to Arecibo observatory, where he developed a special fast-Fourier transform program, which helped to separate period from the noise, and one night he discovered period of the Crab Nebula pulsar, which is approximately 33 ms. This was the fasted pulsar found in 70-s. After this discovery, scientists concluded that pulsars were rotating neutron stars. Before that, many scientists believed that pulsars are pulsating white dwarfs.

Career

Lovelace was Professor at Cornell University from 1972 to 2020. He was Professor in the Department of the Applied and Engineering Physics and the Astronomy Department. He has been teaching different classes for undergraduate and graduate students. For the “Continuum Physics” class, he developed a suite of 14 demonstrations including a Venturi tube and a smoke-ring generator. With one of the students, Greg Stein, he has written a book “Fluid Flows” . He has taught for many years the graduate E & M course on Applied Electrodynamics. Lovelace was Director of Master of Engineering Program 1991–2000. Awarded for Excellence in Teaching from the Engineering Honor Society Tau Beta Pi, 1988.

Lovelace was a member of the Maxwell prize committee of the American Physical Society 2009-2011. He was a member of the Advisory board of the Guggenheim Foundation, 1994-2005. Referee of Phys. Rev. Letters, Physics of Plasmas, Astrophysical Journal, MNRAS, Astronomy and Astrophysics 1972–2020. Divisional Associate Editor, Physical Review Letters, 1997-2000. Associate Editor for Physics of Plasmas, 2003-2019. Editorial board member: Journal of Computational Astrophysics and Cosmology, 2010 - present.

In 1991, he started the US-Russia Collaboration in Plasma Astrophysics. This collaboration helped to achieve many pioneering results in science. This is the only US-Russian collaboration in plasma astrophysics (http://hosting.astro.cornell.edu/us-russia/). In 2000, he initiated the US-Kazakhstan Astrophysics Collaboration, which greatly helped scientists of Kazakhstan, 2000–2004 http://hosting.astro.cornell.edu/research/projects/us-kaz/.

Research

1. In 1969, Lovelace discovered the period of the Crab Nebula pulsar, which is about P=33 ms (Ref. 1, Ref.2). He developed a special fast-Fourier transform program, which helped to separate period from the noise. After this discovery, scientists concluded that pulsars are rotating neutron stars. Before that, many scientists believed that pulsars are pulsating white dwarfs. After discovering such a rapidly rotating star it becomes clear that it had to be a rotating neutron star.

2. Proposed a model of jets from disks surrounding massive black holes in galaxies (Ref. 3). The model is based on the dynamo mechanism acting in the magnetized accretion disk surrounding a black hole or other gravitating object. The model has been widely accepted by the astronomical community and now is the main model explaining jets from galaxies, stars and planets. "Dynamo model of double radio sources" R. V. E. Lovelace 1976, Nature 262 (5570), 649-652.

3. For the first time, suggested that Rossby waves (observed in atmospheres of giant planets, such as the big red spot at Jupiter) are important in astrophysical accretion disks (Ref. 4,5). These waves form vorticies in accretion discs, where dust particles accumulate and are probable places for formation of planets (e.g., Ref.6).

Other Scientific Achievemnts

1. Developed a theory of stability of ion rings in collaboration with H. H. Fleischmann, H. L., Berk and N. Rostocker. The theory is used in the current laboratory experiments on fusion (e.g., in the Triple Alpha Laboratory in California) One of publications on this topic: "Low-frequency stability of astron configurations" 1969 R. V. E. Lovelace Physical Review Letters 35 (3), 162.

2. Proposed a new method of measuring magnetic fields. Patent: United States Patent 6,639,403 A. Temnykh, and R. V. E. Lovelace, October 28, 2003 "System and method for sensing magnetic fields based on movement".

3. Developed pioneering theory of intense ion beams in pulsed diodes, which are currently used in laboratories. "Generation of intense ion beams in pulsed diodes". Publication: R. N. Sudan, and R. V. Lovelace 1973, Physical Review Letters 31 (19), 1174.

4. Proposed the theory of magnetic insulation. The theory is continuously used in laboratories, for example in Sandia National Laboratory. Publication: "Theory of magnetic insulation" R. V. Lovelace, E. Ott 1974, The Physics of Fluids 17 (6), 1263-1268.

5. Invented trapping mechanism of spin-polarized neutral gas. The mechanism has been experimentally demonstrated. Publications: "Magnetic confinement of a neutral gas" R. V. E. Lovelace, C. Mehanian, T. J. Tommila, D. M. Lee 1985, Nature 318 (6041), 30-36; D. Thompson, R. V. E. Lovelace, D. M. Lee "Storage rings for spin polarized hydrogen" 1989, Journal of the Optical Society of America, vol. 611.

6. Developed theory and simulations of scintillations in the interstellar medium. Publication: "Refractive and diffractive scattering in the interstellar medium" J. M. Cordes, A Pidwerbetsky, R. V. E. Lovelace The Astrophysical Journal 310, 737-767.

7. In collaboration with Russian mathematicians, developed a global, three-dimensional numerical model of the disk-accreting magnetized stars. The model is unique and does not have an analogy in the world. Many pioneering results were obtained with this 3D MHD model. This problem is important in astrophysics, because a wide variety of stars have significant magnetic

fields (young stars, white dwarfs, neutron stars), and their observational properties depend on the disk-magnetosphere interaction. One of key papers: "Three-dimensional simulations of disk accretion to an inclined dipole. II. Hot spots and variability" , M. M. Romanova, G. V. Ustyugova, A. V. Koldoba, R. V. E. Lovelace 2004, The Astrophysical Journal 610 (2), 920.

8. Provided the first estimate of the electric current in the astrophysical jet: 3×10^{18} Amps. Publication: "Measurement of the electric current in a kpc-scale jet", P. P. Kronberg, R. V. E. Lovelace, G. Lapenta, and S. A. Colgate 2011, ApJ Letters 741, L15.

Publications:

Ref.1: "Crab nebula pulsar NP 0532" 1969, J. M. Comella, H. D. Craft, R. V. E. Lovelace, J. M. Sutton, G. L. Tyler Nature 221 (5179), 453-454;

Ref. 2: "On the discovery of the period of the Crab Nebula pulsar" R. V. E. Lovelace and G. L. Tyler 2012, The Observatory, 132, 186.

Ref. 3: "Dynamo model of double radio sources" R. V. E. Lovelace 1976, Nature 262 (5570), 649-652.

Ref. 4:"Rossby wave instability of Keplerian accretion disks" R. V. E Lovelace, H. Li, S. A. Colgate, A. F. Nelson 1999, The Astrophysical Journal 513 (2), 805.

Ref. 5: "Rossby wave instability in astrophysical discs" R. V. E. Lovelace & M. M. Romanova 2014, Fluid Dynamics Research , V46, p. 041401