



Prof. Vera Cooper Rubin

Professor



Most important awards, prizes and academies

Awards: US National Medal of Science (1993); Antoinette de Vaucouleurs Medal (1993); Dickson Prize (1994); Russell Prize, American Astronomical Society (1994); Weizmann Women and Science Award (1996); Gold Medal, Royal Astronomical Society (1996); City of Philadelphia John Scott Award (2001); Peter Gruber International Cosmology Prize (2002); Bruce Medal, Astronomical Society of the Pacific (2003); Watson Medal, US National Academy of Sciences (2004). *Academies:* US National Academy of Sciences (1981); American Academy of Arts and Sciences (1982); American Philosophical Society (1995). *Honorary Degrees:* Creighton Univ. (1978); Harvard Univ. (1988); Yale Univ. (1990); Williams College (1993); Univ. Michigan (1996); Georgetown Univ. (1997); Ohio State Univ. (1998); Smith College (2001); Grinnell College (2001); Ohio Wesleyan University (2004); Princeton University (2005).

Summary of scientific research

Vera C. Rubin has devoted her professional career to the study of motions of stars and gas in galaxies, and galaxies in the universe. Her earliest studies (1951) examined the motions of galaxies to see if they exhibited large scale systematic motions, in addition to the general expansion of the universe. She returned to this subject 25 years later with her long-time collaborator, Dr. W. Kent Ford, Jr., this time obtaining new data on the velocities and the

brightnesses of the galaxies. These results indicated a large motion for our Galaxy, and initiated a series of long-term studies still underway today, in an effort by many astronomers to sort out these complex motions. In 1987, she chaired a Vatican Study-Week on Large Scale Motions in the Universe. The major thrust of Dr. Rubin's observations for the past 30 years has been the study of the orbital velocities of stars and gas in galaxies. This work led to the discovery that orbital velocities far from the centers of galaxies are high, too high to be accounted for by the luminous matter observed in galaxies. Hence these studies played an important role in the realization that most of the matter in the universe is dark. Ultimately, Dr. Rubin and her colleagues produced a systematic study of rotational properties for normal galaxies of different classes. Dr. Rubin has extended her observational studies to rotation motions within galaxies located in dense clusters of galaxies, and to galaxies with peculiar morphologies, in an effort to understand the history and evolution of such objects. In this study, she has discovered curious galaxies, such as NGC 4550, a disk galaxy in which half the stars orbit clockwise, and half the stars orbit counterclockwise. She and her colleagues understand this as a galaxy which acquired a substantial amount of gas, after the initial stellar disk was in place. The new gas later precessed to the principal plane and formed stars, whose reverse orbital sense reflected the angular momentum of the acquired gas. Currently, Dr. Rubin and her collaborators are analyzing the motion of stars in low surface brightness galaxies, and in dwarf irregular galaxies. Little is known about stellar motions in these small, undistinguished stellar agglomerations, which are the most numerous galaxies in the universe. The new, large telescopes make these studies possible.

Main publications

Rubin, V.C., Rotation of the Metagalaxy, *Astron. J.*, 56, p. 47 (1951); Rubin, V.C. and Burley, J., Kinematics of Early-Type Stars. II. The Velocity Field within 2 kiloparsecs of the Sun, *Astron. J.*, 69, p. 92 (1964); Burbidge, E.M., Burbidge, G.R. and Rubin, V.C., A Study of the Velocity Field in M82 and Its Bearing on Explosive Phenomena in that Galaxy, *Astrophys. J.*, 140, p. 942 (1964); Rubin, V.C., Radial Velocities of Distant O B Stars in the Anticenter Region of the Galaxy, *Astrophys. J.*, 142, (Oct. 1965); Rubin, V.C. and Ford, W.K. Jr., Rotation of the Andromeda Nebula from a Spectroscopic Survey of Emission Regions, *Astrophys. J.*, 159, p. 379 (1970); Rubin, V.C., Ford, W.K. Jr. and D'Odorico, S., Emission-line Intensities and Radial Velocities in the Interacting Galaxies NGC 4038-4039, *Astrophys. J.*, 160, p. 801 (1970); Rubin, V.C., Ford, W.K. Jr., Thonnard, N. and Roberts, M.S., Motion of the Galaxy and the Local Group of Galaxies Determined from the Velocity Anisotropy of Distant ScI Galaxies. II. The analysis for the Motion, *Astron. J.*, 81, p. 719 (1976); Rubin, V.C., Ford, W.K. Jr. and Oort, J.H., New Observations of the NGC 1275 Phenomenon, *Astrophys. J.*, 211, p. 697 (1977); Rubin, V.C., Burstein, D., Ford, W.K. Jr. and Thonnard, N., Rotation Velocities of 16 Sa Galaxies and a Comparison of Sa, Sb and Sc Rotation Properties, *Astrophys. J.*, 289, p. 81 (1985); Rubin, V.C. and Coyne, G.V., S.J., *Large-Scale Motions in the Universe: A Vatican Study Week*, eds. Princeton University Press, 1988; Rubin, V.C., Graham, J.A. and Kenney, J.P.D., Cospatial Counterrotating Stellar Disks in the Virgo E7/S0 Galaxy NGC 4550, *Astrophys. J. (Lett.)*, 394, L9-L12 (1992); Rubin, V.C., Galaxy Dynamics

and the Mass Density of the Universe, *Physical Cosmology* (D. Schramm, ed.), *Proc. Nat. Ac. Sci.*, 90, p. 4814 (1993); Rubin, V.C., A Century of Galaxy Spectroscopy, *Astrophys. J.*, 451, p. 419 (1995); Rubin, V.C., *Bright Galaxies Dark Matters* (Masters of Modern Physics), AIP Press, 1996; Rubin, V.C., Kenney, J.D.P., and Young, J.S., Rapidly Rotating Circumnuclear Gas Disks in Virgo Disk Galaxies, *Astron. J.*, 113, p. 1250 (1997); Rubin, V.C., Waterman, A.H., and Kenney, J.P.D., Kinematic Disturbances in Optical Rotation Curves among 89 Virgo Disk Galaxies, *Astron. J.*, 118, (1999); Rubin, V.C., A Brief History of Dark Matter, *The Dark Universe: Matter, Energy, and Gravity* (M. Livio, ed.), Cambridge University Press, 1 (2003); Swaters, R.A. and Rubin, V.C., Stellar Motions in the Polar Ring Galaxy NGC4650A, *Astrophysical J. (Lett)*, 587, L23-L26 (2003).