

The AAE Spring 2006 Colloquium Series
presents

The Intriguing Structure of a Sunspot

Dr. John H. Thomas

Professor, Dept. of Mechanical Engrg., and Dept. of Physics & Astronomy
University of Rochester

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3:00 P.M.

GRIS 180

Abstract

Sunspots provide the best test of magnetohydrodynamic theory under astrophysical conditions, for nowhere else in astrophysics is the theory confronted with such a wealth of detailed observations. Recent advances in high-resolution observations provide us with information that has allowed us to begin to assemble a coherent theoretical picture of the formation and maintenance of a sunspot, its complex thermal and magnetic structure, and flows and oscillations within the spot. A new picture of the structure of the outer part of a sunspot (the filamentary "penumbra") has emerged, involving two components, with different magnetic field inclinations, that remain essentially distinct over the lifetime of the spot. The darker component, with a more nearly horizontal magnetic field, contains "returning" magnetic flux tubes that dive back down below the solar surface near the outer edge of the penumbra and carry most of the Evershed outflow. The submergence of these flux tubes, in spite of their inherent magnetic buoyancy, can be understood to be a consequence of downward pumping of the magnetic flux by turbulent granular convection in the "moat" surrounding the sunspot. This flux-pumping process is demonstrated in three-dimensional numerical simulations of fully compressible thermal convection. The flux-pumping mechanism turns out to be an important key to understanding the formation and maintenance of the penumbra and the behavior of moving magnetic features in the moat.

Biographical Sketch

John H. Thomas received his bachelor's (1962), master's (1964), and Ph.D. (1966) degrees in Engineering Sciences at Purdue. As an undergraduate, he was managing editor of the Purdue Exponent and a member of Iron Key, Omicron Delta Kappa, and Tau Beta Pi honorary societies. He did his Ph. D. research in magnetohydrodynamic turbulence under the supervision of Professor Milomir M. Stanisic. After a year as a NATO postdoctoral fellow at the University of Cambridge, England (1966-67), he joined the faculty of the University of Rochester, where he has remained and is currently Professor of Mechanical and Aerospace Sciences and of Astronomy. He also served eight years as Rochester's dean of graduate studies.

His long career at Rochester has been interspersed with visiting appointments at various institutions, including the universities of Oxford, Cambridge, and Sydney, the Max Planck Institute for Astrophysics in Munich, the National Solar Observatory in New Mexico, and the High Altitude Observatory in Colorado. He is a Fellow of the American Physical Society and the Royal Astronomical Society (UK), a former Guggenheim Fellow, and past chair of the Solar Physics Division of the American Astronomical Society. His research interests are in the general area of astrophysical fluid dynamics and magnetohydrodynamics, especially as applied to the Sun. In addition to his theoretical work, he has made several observational studies of sunspots.

An informal coffee & cookie reception will be held prior to the lecture at 2:30 p.m. in GRIS 390

COLLOQUIUM