Australian Ph.D. Theses in Astronomy: Abstracts

THE EVOLUTION OF ACTIVITY IN POST-MAIN-SEQUENCE STARS

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Optical and radio studies of late-type post-main-sequence stars are presented. Using levels of excess calcium emission and non-thermal radio emission as indicators of stellar activity, the effects of the evolution of stellar structure on magnetic activity and the dynamo process are examined.

Calcium spectra of a homogeneous sample of late-type post-main-sequence stars in the Galactic open clusters NGC2451, NGC2477 and IC4756 taken using the fibre optic systems of the Anglo-Australian Telescope are presented. A method of calibrating the observed spectra to absolute surface flux units is derived. Our activity indices suggest that the model for the decline of activity for $2M_{\odot}$ stars proposed by Rutten & Pylyser (1988) significantly overestimates the levels of activity for such stars. Our results indicate that the assumption of rigid-body rotation and/or conservation of total angular momentum must be relaxed in future studies of post-main-sequence stellar rotation and activity.

A radio survey of 24 post-main-sequence single stars made with the Australia Telescope and the Molonglo Observatory Synthesis Telescope is presented. Detections of variable microwave emission from this sample of stars had been claimed from observations made with the Parkes radio telescope. Our survey of this sample detected none of the 24 stars, with a 4σ detection level of ~1 mJy. A re-analysis of the original Parkes data indicates that the claimed sensitivity limit in that survey was significantly underestimated.

MOST observations of the active star AB Dor (HD 36705) made as part of a 1990 international campaign to observe the star are presented. MOST observations from 1985 to 1990 detect a weak variable source close to the optical position. The star has a physical companion RST 137B, which has recently been found to be a highly active star itself. An examination of the variations in position with flux density suggests that the MOST source is the confused emission from both stars. An examination of the currently-accepted pre-main-sequence model for AB Dor indicates a number of potential flaws in this classification, and a post-main-sequence model for the star is proposed.

In conclusion, the phenomenology of post-main-sequence stellar activity is discussed. A theoretical measure of dynamo efficiency (the Rossby number) is derived for our sample of open cluster stars. This parameter suggests a relatively constant dynamo efficiency as stars evolve toward the red giant branch.

MAPPIT: OPTICAL INTERFEROMETRY WITH THE ANGLO-AUSTRALIAN TELESCOPE

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Turbulence in the Earth's atmosphere usually prevents large optical telescopes from achieving their full resolving power. Instead, the image of a star is blurred to a seeing disk about 1 arcsec in diameter. Several techniques are available which use interferometry to overcome atmospheric seeing and restore diffraction-limited performance. This thesis describes the design, construction and use of an optical interferometer located at the coudé focus of the 3.9-m Anglo-Australian Telescope. The instrument, known as MAPPIT (Masked APerture-Plane Interference Telescope), uses the technique of non-redundant masking. This involves placing a mask with several small holes over the aperture of the telescope and recording a succession of short-exposure interferograms. These interferograms are analysed to determine the power spectrum and closure phases of the object, which are used to reconstruct a diffraction-limited image.

One advantage of using a non-redundant aperture mask is that, at least for bright objects, it increases the signal-to-noise ratios of the power spectrum and closure phase measurements relative to observations with an unobstructed aperture. This is despite the fact that much of the light is blocked by the mask. Another advantage is that it improves the accuracy with which one can correct for variations in atmospheric seeing, something which is often the limiting factor in high-resolution imaging. The main drawback of non-redundant masking is a less efficient coverage of spatial frequencies. However, for simple objects such as multiple and barely resolved stars, adequate spatial frequency coverage can be obtained by combining observations made with different masks and with the masks rotated to several different position angles on the sky.

An important feature of MAPPIT is the use of a prism to disperse the interference pattern in wavelength. This overcomes a restriction common to all forms of interferometry, namely, the requirement that one observe over a narrow band of wavelengths. By using an aperture mask with a linear array of holes, one obtains a one-dimensional fringe pattern which can then be dispersed in the direction parallel to the fringes. In MAPPIT, a prism and a cylindrical lens produce wavelength-dispersed fringes using a novel combination of image-plane and pupil-plane imaging.

Results presented in this thesis include observations of several close double stars. One of these is δ Sco, and I provide the first image of this star and the first determination of its orbit. Another bright star, σ Sgr, is found to a barely-resolved double with a separation of just 12 milliarcsec. Observations of two resolved single stars, α Sco and β Gru, are also reported. The measured angular diameter of alpha Sco agrees well with published values. For the M5III giant beta Gru, which has not previously been resolved, I find a uniform-disk diameter of 27 ± 3 milliarcsec.

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