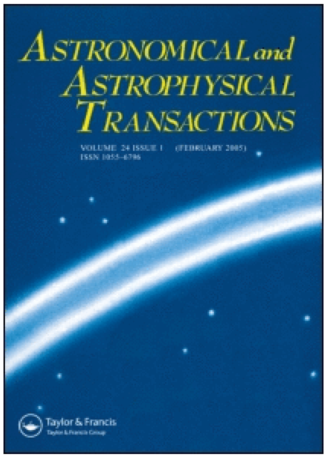

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The brightness distributions across a stellar disk inferred from lunar occultation observations

M. B. Bogdanov [a]
[a] Saratov University, Russia

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THE BRIGHTNESS DISTRIBUTIONS ACROSS A STELLAR DISK INFERRED FROM LUNAR OCCULTATION OBSERVATIONS

M. B. BOGDANOV

Saratov University, Russia

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A method for obtaining the brightness distribution across a stellar disk from lunar occultation observations is proposed. The method of analysis of occultation curves is based on Tikhonov's regularization theory, which invoke a priori information about the solution.

KEY WORDS stars, brightness distributions, lunar occultations

Lunar occultations provide the way to reach high angular resolution through analysis of the light curve produced when a source disappears behind or appears again from behind the limb of the Moon. This method also offers the greatest sensitivity and resolution currently available, at least in the near-IR.

The observed occultation curve is a result of convolution of one-dimensional strip brightness distribution across the source with the Fresnel diffraction curve for a point source, degraded by instrumental effects (including finite bandwidth, telescope aperture and integration time). The restoration of brightness distribution is an ill-posed problem in the sense of Hadamard, with no stable solution in the presence of a noise. We propose methods of analysis of occultation curves based on Tikhonov's regularization theory, which invoke *a priori* information about the solution. The nonlinear regularized algorithm yields a smooth strip brightness distribution basing on the constraint that the desired solution is non-negative. If the strip brightness distribution across the source is an even function then solution of the convolution equation can be obtained in the class of monotonic and bounded non-negative functions.

When the source is circularly symmetric, the strip distribution is related to the radial brightness distribution via Abel's integral equation. This also represents an ill-posed problem and the search of solution is carried out in the monotonic and bounded functions class. We propose a method which allows to find the radial brightness distribution across a source directly from the occultation curve under the presumption of circular symmetry. All these methods possess a good stability against stochastic noise and also can be used for analysis of lunar occultations of radio sources.

We apply these methods to analysis of lunar occultation data for the carbon star TX Psc and red giants λ Aqr and μ Gem, obtained by different authors in visible light. Furthermore, we also consider near-IR occultation observations of red giants FY Lib and SW Vir and Mira variables U Ori, Z Sgr, and S Vir, carried out at Kitt Peak National Observatory by S. T. Ridgway's group. The restored strip distributions and radial brightness distributions across the disks show that atmospheres of these stars are not very extended. The brightness distributions agree qualitatively with results of modern static–atmosphere model calculations for red giants and dynamic–atmosphere model calculations for long-period variables.