CHROMATIC AND SPECTROSCOPIC SIGNATURES OF MICROLENSING EVENTS

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Abstract. We predict that chromatic and spectroscopic effects are likely to appear for a significant fraction of microlensing events. Differential amplification across a stellar disc produces a time and wavelength dependent signature which constrains the parameters of the lenses and can be used for 3-D mapping of stellar atmospheres.

1. Introduction

The recent detections of microlensing events towards the LMC and the Galactic bulge raise constraints on the distribution of the lenses and sources. The large detection rate in the bulge might be due to lenses in the bulge itself and the low rate of the LMC could be explained by lenses within the LMC. If this is the case, a significant fraction of events is produced by lenses with an angular Einstein radius similar to or smaller than the angular radius of the stars and the structure of the source becomes important.

2. Chromatic and spectroscopic effects

Using the latest (1993) atmosphere models from Kurucz we have computed the limb-darkened profiles for a large variety of stellar models. Figure 1a presents simulated light curves in different photometric bands for a red giant star of solar metallicity. The amplitude of the effect is large enough (4 to 10%) to be be reached with differential photometry.

There is an associated spectroscopic effect due to the systematic variation of the line profile across the stellar disc. It depends on the nature of the line and on the optical depth gradient in the atmosphere. One can

C. S. Kochanek and J. N. Hewitt (eds), Astrophysical Applications of Gravitational Lensing, 237–238.

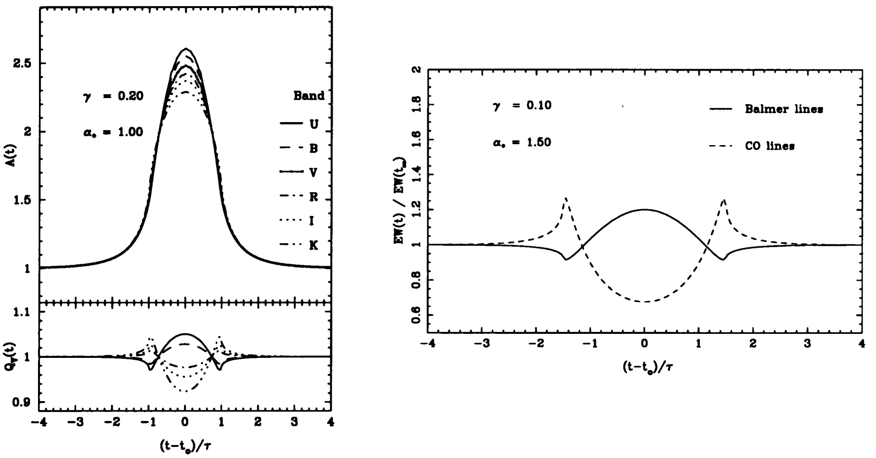

Figure 1. *(a)* [left] chromatic signatures, $Q_V = A/A_V$, *(b)* [right] spectroscopic effect.

then envision microlensing tomography, a 3-D reconstruction of the stellar atmosphere based on the measure of the time-varying line profiles. Given the present instrumentation, an easier observable is given by the equivalent widths (EWs). We show in Figure 1b the variation of EWs for two different types of lines: the Balmer lines, and the infrared CO lines. Their different behavior reflects the gradient in temperature at the depth of formation.

3. Conclusions

A significant fraction of microlensing events could present a chromatic effect, with a systematic variation with wavelength and an amplitude between 4 and 10% in magnification. The use of photometric bands as widely separated in λ as possible improves the detectability of the effect. The amplitude of the spectroscopic effect depends strongly on the type of line. The variation in EW reaches the 40% level, and should be detectable with current instrumentation. If detected, these effects provide: (1) a unique proof of microlensing, as opposed to a new type of stellar variability; (2) constraints on the Einstein radius and reduced proper motion of the lens (assuming the stellar radius can be inferred); and (3) a new imaging method to map stellar surfaces, not only across the stellar disc, but also with depth.

References

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