Dark Matter in Galaxies
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MEGA: Microlensing Exploration of the Galaxy and Andromeda

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Abstract. Microlensing surveys have ruled out that the dark halos of the Milky Way and M31 are composed entirely of massive compact halo objects (MACHOs) for a wide range of MACHO masses. We have tried using the Subaru telescope to improve the limit on Moon-mass MACHOs, which is the lowest decade in MACHO mass that can be probed by microlensing. Unfortunately, only a half-night of Subaru data was obtained and this is not enough; at least 2 nights of data are required. The current limit is based on nearly 6 years of observations with smaller telescopes.

1. Introduction

Naively, the Galactic dark halo could be composed entirely of objects that are less massive than 1% of the Sun because these mass objects must be dark. However, other limits apply. For example, the dark halo cannot be made entirely of objects with masses of about $10^{-10}\ M_\odot$ otherwise the sky would be filled with comets (Carr & Sakellariadou 1999). Microlensing surveys have shown that no more than 5% of the dark halo could be composed of objects with masses from 10^{-7} to $10^{-3}\ M_\odot$ (Alcock et al. 1998). In the allowed low-mass range MACHOs could be made of solid hydrogen (White 1996), or strange quarks (Banerjee et al. 2003), or they could be black holes (Green & Liddle 1999).

2. Microlensing with an 8-m Telescope

The venue for pushing the microlensing limits to smaller masses is not the Magellanic Clouds, where Alcock et al. (1998) searched, but in a more distant galaxy like M31 (e.g., Baltz, Gyuk & Crotts 2003). Here the loss of detectability that results from the finite size of the source does not become a problem until the lenses in the Galactic halo are less than $10^{-8}\ M_\odot$, i.e. Moon-mass. However, to acquire enough signal on faint source stars in M31 on sub-hourly timescales requires a large telescope. The MEGA survey was allocated 2 nights with Subaru for this experiment. Due to weather, only 1/2 night of useful data was obtained. In addition, a significant fraction of the M31 signal in this dataset was also lost due to a readout problem with one CCD in the mosaic imager.

Figure 1 shows the number of microlensing events expected in each dataset for a 100% halo of MACHOs as a function of MACHO mass. The significance of

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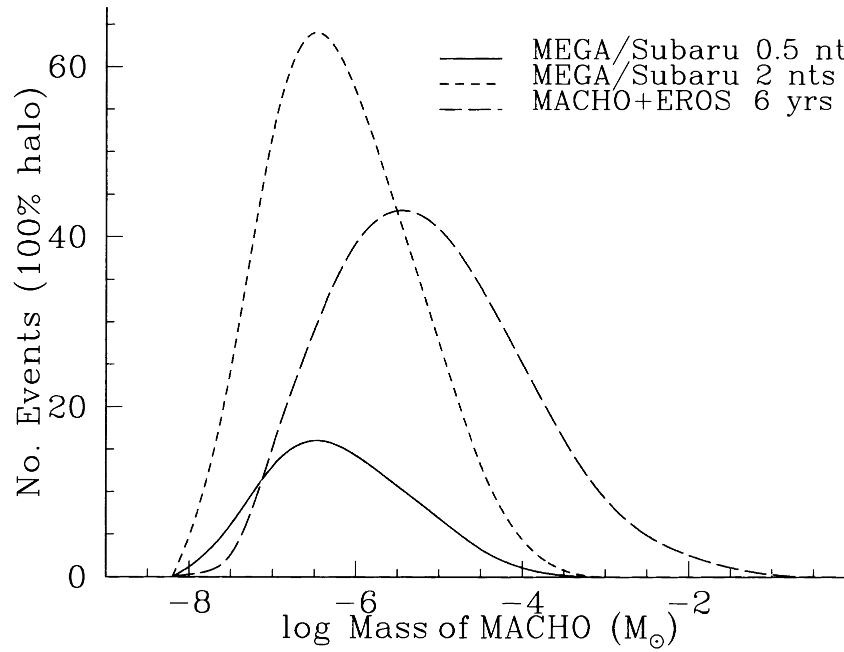

Figure 1. Predicted number of events for a 100% halo as a function of MACHO mass for different microlensing datasets. The long-dashed line shows the prediction from Alcock et al. (1998) for their 6-year dataset (M. Lehner, *priv. comm.*). MEGA's prediction for a half-night (solid line) and two nights (short-dash line) of Subaru data are overplotted.

the limit on the halo fraction is proportional to the square-root of the number of predicted events if no microlensing is detected. Although we predict slightly more low-mass events in the half-night dataset compared to Alcock et al. (1998), the actual number would be less because of the data lost to the malfunctioning CCD. In 2 nights an as yet unprobed decade in MACHO mass could be ruled out.

3. References

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