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THE GRAVITATIONAL MICROLENSING SCENARIO FOR PKS 0537–441

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RESUMEN

La amplificación gravitacional por objetos compactos de componentes supralumínicas en el blázar PKS 0537–441 es propuesta como método para detectar objetos con masas en el rango de 10^{-4} a 1 $M_\odot$ pertenecientes a una galaxia interpuesta sobre la línea de la visual con el blázar. Un frente de choque relativista en el jet del blázar puede producir eventos de magnificación gavitacional en el óptico con escalas temporales de $1-3$ días, cuando estrellas con masas en el rango de $0.1-1\ M_\odot$ actúan como lentes, y con escalas temporales desde 30 minutos a 1 día, cuando las lentes son enanas marrones de $10^{-4}-10^{-1}\ M_\odot$. La profundidad óptica total estimada para eventos con amplificación mayor a $A_\mathrm{o}=2$ es $\tau \approx 0.2$. En caso de que la propagación de un frente de choque relativista a través del jet del blázar produzca una componente supralumínica en el mismo, un seguimiento de la fuente durante un período de observación de 30 días podría detectar varios eventos. La cantidad y escala temporal de los eventos registrados puede ser usada para develar la función de masa de los objetos compactos en la galaxia interviniente. Para una función de masa $N(M) \propto M^{-2}$ en el rango $10^{-4}-1\ M_\odot$, se espera que en un lapso de 30 días se produzcan un evento estelar y 19 eventos por enanas marrones.

ABSTRACT

Gravitational microlensing of the superluminal components of the southern blazar PKS 0537–441 is proposed as a method for detecting objects with masses between 10^{-4} and 1 $M_\odot$ in a foreground galaxy. A relativistic shock in the jet of the blazar can produce microlensing events on time scales of $1-3$ days for lensing stars with masses in the $0.1-1\ M_\odot$ range, and on time scales ranging from 30 minutes to 1 day for lensing brown dwarfs of $10^{-4}-10^{-1}\ M_\odot$ at optical wavelengths. For events with amplification larger than $A_\mathrm{o}=2$, a total optical depth $\tau \approx 0.2$ is estimated. We predict that monitoring the source during an observing period of 30 days should reveal several microlensing events in case that the relativistic propagation of a shock front through the blazar's jet creates a superluminal source component. The number and time scales of the resulting variability events can be used to enlighten the question about the mass function of compact objects in the foreground galaxy. For a mass function $N(M) \propto M^{-2}$ in the $10^{-4}-1\ M_\odot$ range, 1 star event and 19 brown dwarf events are expected to be produced in a lapse of 30 days.

Key words: **BL LACERTAE OBJECTS–INDIVIDUAL–PKS 0537-441 — DARK MATTER — GRAVITATIONAL LENSING — STARS–LOW MASS, BROWN DWARFS**

1. INTRODUCTION

The nature of the dark matter existing in galactic halos is uncertain. There are two kinds of proposed candidates for such matter: (1) massive compact

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halo objects (MACHOs), which include astrophysical objects with masses below the nuclear ignition threshold of $\sim 0.1\ M_\odot$ (brown dwarfs), and stellar remnants like white dwarfs, neutron stars, or black holes; and (2) weakly interacting massive particles (WIMPs), such as massive neutrinos or axions.

Dark matter under the form of MACHOs can be detected by gravitational microlensing. When one of these compact objects crosses close to the line of sight to a background source, its gravitational field acts as a lens producing two unresolvable microimages of the source and an amplification of its apparent luminosity. The possibility of gravitational microlensing of quasars by stars in foreground galaxies has been suggested and studied by several authors (Refsdal 1964; Chang & Refsdal 1979, 1984; Gott 1981; Young 1981; Narasimha, Subramanian, & Chitre 1984; Subramanian, Chitre, & Narasimha 1985; Paczyński 1985; Nottale 1986; Kayser, Refsdal, & Stabell 1986; Wambsganss, Paczyński, & Schneider 1990; Wambsganss & Paczyński 1991; Refsdal & Stabell 1993). The typical time scale for these "distant" microlensing events is long, in the range from several months to years, and consequently the search of MACHOs has been oriented towards our own galaxy (Packzyński 1986), where the distances to the lenses make the expected time scales for "local" microlensing much shorter, of the order of a month or less. This local search has the disadvantage that, due to the low probability of lensing events, the observing programmes are compelled to monitoring several millions of stars with the consequent complications. Three ongoing experiments, EROS, MACHO, and OGLE, have recently reported several possible microlensing events (e.g., Alcock et al. 1993; Aubourg et al. 1993; Udalski et al. 1993), whose agreement with different model predictions is still under discussion (see, e.g., Packzyński et al. 1994; Sahu 1994, and references therein). Conversely to these local experiments, the potential of distant gravitational microlensing for detecting extragalactic dark compact objects has not been fully explored yet. Gopal-Krishna & Subramanian (1991) showed that superluminal bright emission regions in jets of quasars could produce flux density variability on short time scales when microlensed by stars in a foreground galaxy. This "superluminal" microlensing could be a powerful tool for exploring the number and mass distribution of compact objects in the intervening galaxies.

In this article we propose the southern blazar PKS 0537-441 as a good candidate for a search of extragalactic MACHOs, that might be a complementary alternative to the observations now in progress for detecting local microlensing in our own galaxy. PKS 0537-441 is an extremely luminous blazar (Impey & Neugebauer 1988), with an apparent magnitude $m_v = 16.40$. At radio frequencies it presents a very compact structure (angular diameter ~ 1.1 mas, see Preston et al. 1989) and a flux density $S_{1.4\ \mathrm{GHz}} \sim 3.3$ Jy (Romero, Combi, & Colomb 1994). The Compton Gamma Ray Observatory has detected strong emission from PKS 0537–441 at GeV energies (Fichtel et al. 1994). This blazar, with a redshift $z_s = 0.894$, has all the required features to display distant gravitational superluminal microlensing. There is a report of a foreground galaxy, with possible redshift $z_d = 0.186$, on the line of sight to this source (Stickel, Fried, & Kuhr 1988). Blazars are usually considered as a site of superluminal motions (e.g., Qian et al. 1991; Ghisellini et al. 1993; Romero, Combi, & Vucetich 1995a). In the case of PKS 0537–441, recently reported radio outbursts with amplitudes larger than 1.4 on time scales of hours (Romero et al. 1994) have been interpreted as possibly originated by gravitational microlensing by masses of $\sim 10^{-4}\ M_\odot$ (Romero, Surpi, & Vucetich 1995; hereafter RSV). Other reported radio variability events with time scales of a few days can be interpreted as the effect of microlensing by 1 $M_\odot$ stars (Romero, Benaglia, & Combi 1995b).

We present here the formulae for the superluminal microlensing event time scales, optical depth, and number of expected events on the basis of a simple model. Gravitational microlensing by brown dwarfs in the intervening galaxy with masses in the $10^{-4} - 10^{-1}\ M_\odot$ range is expected to yield a significant number of events during a 30 day observing period on time scales from minutes to days. The reliability of the proposed search is testable by the flux density variations expected to arise from common lensing stars of $0.1 - 1\ M_\odot$ in the galaxy. This programme seems to be feasible and attractive since just one strong source has to be monitored and the observations can be made not just at optical frequencies but also at radio wavelengths. A price to pay is the difficulty for separating in the light curves the microlensing events from intrinsic-to-blazar variability. However, the signatures of microlensing, i.e., time symmetry, and uncorrelation between time scale and peak amplification, are tools sufficient — in principle— for a successful identification of the events. In addition, ultra-rapid variability presents several problems to intrinsic shock-in-jet models for blazars that could be avoided by the microlensing interpretation (see Marscher 1992 for a detailed discussion about these problems).

2. MODEL

Let us consider a relativistic transverse shock propagating along the parsec-scale jet of PKS 0537–441. These kind of shocks can appear as superluminal sources not just in the observer's plane but also in the plane of the lenses. The microlensing magnification of the shock emission by objects in the foreground galaxy will be perturbed by the macrolensing exerted by the gravitational field of the galaxy as a whole. This macrolensing is described by the focusing κ and the shear parameter γ, at the location of the lensing mass. In the case of PKS 0537–441, since the center of the galaxy seems to be finely aligned with the blazar (Stickel et al. 1988), the shear becomes negligible with respect to the focusing, and the latter can be approximated by $\kappa = \Sigma_c/\Sigma_{crit}$. In this expression Σ_c is the central surface density of the foreground galaxy, and Σ_{crit} is the critical density required to produce multiple imaging of a perfectly aligned source given by $\Sigma_{crit} = c^2 D_s/4\pi G D_d D_{ds}$, with D_s, D_d, and D_{ds} the source, lens, and source-lens angular diameter distances, respectively.

In this situation, during a microlensing event, the total amplification A of the source (i.e., the shocked region in the blazar with apparent superluminal velocity v_{app} in the lens plane) is given by the time symmetric curve (see RSV for details)

$$A = 1 - \frac{1}{(1-\kappa)^2} + \frac{2(1-\kappa)+u^2}{(1-\kappa)^2 u\sqrt{4(1-\kappa)+u^2}}, \qquad (1)$$

where u is the distance from the source to the microlens with mass M in the lens plane, in units of the Einstein radius $R_e = [4GMD_dD_{ds}/c^2D_s]^{1/2}$. The size of the source is sufficiently small to work in the point-source approximation (see, for instance, Nottale 1986). The variable u can be written as a function of the relative source-to-lens trajectory as

$$u = \sqrt{d_o^2 + \left(t - t_{\frac{m}{t_o}}\right)^2}, \qquad (2)$$

where d_o is the impact parameter in units of R_e, t_m is the instant of maximum amplification, and $t_o \equiv R_e/v_{app}$ is the microlensing event time scale.

When an event is identified in the data, the mass of the microlens can be computed with enough accuracy in spite of the uncertainty about the actual value of κ from the observed time scale (RSV). Using the angular diameter distances corresponding to PKS 0537–441 and its foreground galaxy: $D_s = 0.866h^{-1}$ Gpc, $D_d = 0.414h^{-1}$ Gpc and $D_{ds} = 0.606h^{-1}$ Gpc, where h is the value of the Hubble constant in units of 100 km s^{-1} Mpc^{-1} and a Robertson-Walker Universe with $q_0 = 0.5$ has been considered, we obtain

$$M = 0.013h\left(\frac{t_o}{\text{day}}\right)^2\left(\frac{v_{app}}{c}\right)^2 M_\odot. \qquad (3)$$

Owing to the superluminal source motion the optical depth and number of events will not significantly depend on the velocity distribution of the lenses, and due to the fine source-lens-observer alignment there will be no dependence on peculiarities of the structure and shape of the halo. The only galactic parameter on which the calculations are significantly sensitive is the central surface mass density Σ_c. If just events with peak amplification greater than a certain value A_o are taken into account, the impact parameters must be smaller than $d_o(\kappa, A_o)R_e$ (for instance, $d_o = 1$ in the usual case $A_o = 1.34$, with $\kappa = 0$). The optical depth to microlensing for these events results

$$\tau = \frac{\pi d_o^2(\kappa, A_o)R_e^2\Sigma_c}{M} = d_o^2(\kappa, A_o)\kappa, \qquad (4)$$

where the relation $\kappa = \Sigma_c/\Sigma_{crit}$ and the definitions of Σ_{crit} and R_e have been used in the second equality. If we consider as microlensing events those with maximum amplification greater than $A_o = 2$, the optical depth becomes

$$\tau = 2\kappa\left[\kappa - 1 + \frac{\kappa^2 - 2(\kappa-1)}{\sqrt{3 - 2\kappa + \kappa^2}}\right] \qquad (5)$$

Σ_c represents the total mass included in a cylinder of unit section perpendicular to the galactic plane in the center of the galaxy. In the simplest disk-halo model, Σ_c contains luminous disk matter made of ordinary stars, and halo (and eventually disk) dark matter. If the dark matter is supposed to be mainly constituted by compact objects (e.g., brown dwarfs), the optical depth computed in equation (4) represents the addition of the probability of microlensing by common stars and dark objects.

In order to estimate the possible number of expected events, we need to assume some parametrization for the mass function of the lenses. Theories of star formation based on hierarchical fragmentation (Hoyle 1953) predict a power-law mass function $N(M) \propto M^{-\alpha}$. This kind of parametrization has became very common and is in reasonable agreement with the available data despite the fact that it is no more than an over simplified representation (D'Antona & Mazzitelli 1986; Richter et al. 1991; Tinney 1993). Investigations suggest that a single power law would not fit the mass function for all stars. More masive stars require a steeper power law and less masive stars a shallower one. The power-law mass function has frequently been extended into the substellar regime to make dark matter predictions in our galaxy (D'Antona & Mazzitelli 1986; Nelson & Rapport 1986; Laughlin & Bodenheimer 1993; Kiraga & Paczyński 1994), although at present there is no evidence of its validity in such lower mass range. The Salpeter index $\alpha = 2.35$ (Salpeter 1955) is usually adopted for such calculations. A lower value $\alpha \sim 1$ could also be suggested for doing the extrapolation into the dark matter domain since it seems to be more appropriated to describe the mass function of low mass stars. In order to make some predictions we shall assume a power-law mass function $N(M) \propto M^{-\alpha}$ for $M_{\rm min} \leq M \leq M_{\rm max}$. We emphasize that there is no serious physical justification for this $N(M)$, but we expect that the proposed search could enligthen the questions about the mass function of the different compact objects in the foreground galaxy. We normalize the mass function to yield a total surface mass density $\Sigma_{\rm c} = \kappa\Sigma_{\rm crit}$ at the center of the galaxy. Then, the differential surface density in objects with masses between M and $M + dM$ at the center is

$$d\Sigma_{\rm c} = \frac{\kappa\Sigma_{\rm crit}}{\int_{M_{\rm min}}^{M_{\rm max}} MN(M)dM}\, MN(M)dM. \quad (6)$$

Using equations (4) and (6), and the assumption that $N(M) \propto M^{-\alpha}$, we find that the optical depth to microlensing by objects with masses between M and $M + dM$ is

$$d\tau = \frac{d_{\rm o}^2}{\Sigma_{\rm crit}}\, d\Sigma_{\rm c} = \frac{\tau}{B(\alpha, M_{\rm min}, M_{\rm max})} \times \left(\frac{M}{M_\odot}\right)^{1-\alpha} d\left(\frac{M}{M_\odot}\right), \quad (7)$$

where

$$B(\alpha, M_{\rm min}, M_{\rm max}) = \begin{cases} \frac{1}{2-\alpha}\left[\left(\frac{M_{\rm max}}{M_\odot}\right)^{2-\alpha} - \left(\frac{M_{\rm min}}{M_\odot}\right)^{2-\alpha}\right] & \text{if } \alpha \neq 2, \\ \ln(M_{\rm max}/M_{\rm min}) & \text{if } \alpha = 2, \end{cases} \quad (8)$$

and τ is the total optical depth.

If the lenses have the same mass, and the observing period Δt is greater than the time scale of the events, the expected number of events N will be (Subramanian & Gopal-Krishna 1991)

$$N = \frac{2\tau\Delta t}{\pi d_{\rm o} t_{\rm o}}. \quad (9)$$

For lenses in the range $M_{\rm min} \leq M \leq M_{\rm max}$, the number of expected events with masses between M and $M + dM$ during Δt becomes

$$dN = \frac{2\Delta t}{\pi d_{\rm o} t_{\rm o}(M)} d\tau(M). \quad (10)$$

Setting $t_{\rm o} = R_{\rm e}/v_{\rm app}$, replacing $R_{\rm e}$ and $d\tau$ by their explicit expressions, and using the corresponding values of the angular diameter distances for this case, we get

$$dN = 2.16\, \frac{\sqrt{\kappa\tau}}{B}\, \frac{\Delta t}{30\rm days}\, \frac{v_{\rm app}}{c} \times \left(\frac{M}{M_\odot}\right)^{\frac{1}{2}-\alpha} d\left(\frac{M}{M_\odot}\right). \quad (11)$$

where B is given by equation (8).

3. RESULTS

The predictions of the simplified model introduced in the previous section depend on four parameters: the focusing κ (or equivalently the central surface mass density of the foreground galaxy), the velocity of the superluminal shock in the lens plane $v_{\rm app}$, the index of the power-law mass function α, and the minimum mass in the distribution of microlenses, $M_{\rm min}$. The value of $M_{\rm max}$ can be reasonably fixed at 1 $M_\odot$.

With respect to κ, its value can be constrained to the $0 < \kappa \leq 1$ range by the fact that only one macroimage of the blazar is observed (Narayan & Schneider 1990). An even more restricted range can be obtained analyzing the magnification m of the macroimage of the blazar. For instance, the ratios of PKS 0537-441's luminosity to the luminosity of objects of the same kind and similar redshift like 0133+476, 0336-019, 0420-014, 0454-234, and 2251+158 are 6, 1.6, 1.7, 3.3, and 2.4, respectively (Impey & Neugebauer 1988). This suggest $1.5 \lesssim m \lesssim 6$ as a reasonable range for the magnification which, consequently, constrains the focusing to the range $0.2 \lesssim \kappa \lesssim 0.6$. Thus, from equation (5), the total optical depth to microlensing by events with maximum amplification higher than 2 results $0.08 \lesssim \tau \lesssim 0.47$.

The superluminal velocity of shocks in extragalactic sources has been statistically studied by Ghisellini et al. (1993). They found a connection between the observed velocities and the different type of AGNs where the phenomenon occurs. For the blazar class the characteristic apparent velocities $v_{\rm app}$ of superluminal motions in the source plane seem to be in the $6c \leq v_{\rm app} \leq 8c$ range. Then, the velocity of a superluminal knot in PKS 0537–441 projected in the lens plane would be probably constrained to the $3c \lesssim v_{\rm app} \lesssim 4c$ range. Thus, from equation (3) we can estimate the typical time scale of the possible microlensing events obtaining, for instance, $t_{\rm o}(1\ M_\odot) = 2.2-3$ days, $t_{\rm o}(0.1\ M_\odot) = 17-22$ hours, $t_{\rm o}(10^{-2}\ M_\odot) = 5-7$ hours, $t_{\rm o}(10^{-3}\ M_\odot) = 1.7-2.2$ hours, and $t_{\rm o}(10^{-4}\ M_\odot) = 30-40$ minutes.

Using equation (11) for typical values $\kappa = 0.4$ and $v_{\rm app} = 3.5c$, the expected number of events with masses in a certain range (M_1, M_2) included in the total mass range $(M_{\rm min}, M_{\rm max})$ during 30 days of source observations is

$$N^{30d}_{M_1-M_2} = 2.28\,\frac{D(\alpha, M_1, M_2)}{B(\alpha, M_{\max}, M_{\min})}, \qquad (12)$$

where

$$D(\alpha, M_1, M_2) = \begin{cases} \frac{2}{3-2\alpha}\left[\left(\frac{M_2}{M_\odot}\right)^{\frac{3}{2}-\alpha} - \left(\frac{M_1}{M_\odot}\right)^{\frac{3}{2}-\alpha}\right] & \text{if } \alpha \neq \frac{3}{2}\,, \\ ln(M_2/M_1) & \text{if } \alpha = \frac{3}{2}\,, \end{cases} \qquad (13)$$

and $B(\alpha, M_{\min}, M_{\max})$ is given by equation (8). If the observational campaign is carried out at radio wavelengths with a single dish telescope light curves with a temporal resolution of $\sim$ 20 minutes might be obtained (see Romero et al. 1994 for details of this kind of observations). Owing to the strong flux density of the source no high sensitivities are required; for instance, a sensitivity of $\sim$ 0.15 Jy should be sufficient to detect the expected microlensing events at 1.4 GHz. Low observing frequencies at radio (ν < 1.5 GHz) would be preferable because no intrinsic events are expected to produce significant changes in flux density at these frequencies over time scales of a few hours (otherwise extremely high brightness temperatures well beyond the inverse Compton limit should be posited for the emission region, see Marsher 1992). The total duration of the campaign would depend on the telescope tracking time for a single source. Notice that equation (12) refers to the actual observing time and not to consecutive days. At optical wavelengths rather small telescopes can be used due to the relatively large apparent magnitude of the blazar.

It can be seen from equations (12) and (13) that the model predictions are strongly dependent on the mass function index, the number of events increases with decreasing mass interval if $\alpha > 3/2$, and decreases if $\alpha < 3/2$.

In order to make some illustrative predictions, we shall assume that all dark mass is under the form of MACHOs, and compact objects in the galaxy are distributed in the mass range $M_{\min} \leq M \leq M_\odot$ according to a mass function $N(M) \propto M^{-2}$. We consider four possible cases, labeled i-iv, with different lower masses $M_{\min}/M_\odot = 0.1, 10^{-2}, 10^{-3}$, and 10^{-4}, respectively. In all cases the mass function is normalized to produce the same total surface mass density at the center of the galaxy, and we set this value in accordance with a focusing $k = 0.4$. In cases ii, iii and iv we divide the total mass range into intervals and, assuming $v_{\rm app} = 3.5$, we evaluate the expected number of events during a 30 days monitoring period at each interval by means of equations (8), (12), and (13). The results are shown at Table 1, columns 3 to 6. The total number of expected events in cases i-iv is displayed in the last column of the table. Notice that, from equation (11), in order to obtain the number of events for other values of κ and $v_{\rm app}$ the numbers on each interval $N^{30d}_{M_1-M_2}$ of Table 1 must be multiplied by a factor $\sqrt{\kappa\tau}\, v_{\rm app}/1.06$.

4. DISCUSSION

The gravitational microlensing events described in the previous sections can occur only if the radius of the background source in the lens plane is smaller than the Einstein radius of the microlenses. The thickness of shocked regions in relativistic jets can be as small as 10^{-2} pc at centimeter wavelengths (e.g., Qian et al. 1991). If we adopt the usual geometry of shock-in-jet models of blazars (e.g., Eichler & Smith 1983), this lower limit implies that just compact ob-

TABLE 1

NUMBER OF EXPECTED EVENTS DURING A 30 DAYS MONITORING PERIOD AT SEVERAL MASS INTERVALS FOR DIFFERENT CASES OF TOTAL MASS RANGE

Case	Total Mass Range ($M_\odot$)	$N^{30d}_{10^{-4}-10^{-3}}$	$N^{30d}_{10^{-3}-10^{-2}}$	$N^{30d}_{10^{-2}-10^{-1}}$	$N^{30d}_{10^{-1}-1}$	$N^{30d}_{\rm total}$
i	$10^{-1}-1$	...	...	...	4	4
ii	$10^{-2}-1$	...	...	7	2	9
iii	$10^{-3}-1$	...	14	5	1	20
iv	$10^{-4}-1$	34	11	3	1	49

Note: The adopted mass function is $M^{-\alpha}$, with $\alpha = 2$. The total mass in all cases is fixed by a focusing $\kappa = 0.4$. An apparent velocity $v_{\rm app} = 3.5c$ has been used. The subscripts in the N^{30d} are in $M_\odot$ units. Only events with amplification greater than 2 are computed.

jects with masses $M \geq 10^{-2}\ M_\odot$ could produce significant magnifications of the radio emission from shocks with $v_{\rm app} \sim 3.5c$ in the case of PKS 0537–441. At optical wavelengths the microlenses should have masses greater than $10^{-4}\ M_\odot$ in order to produce the required flux amplification. This is due to the decrease of the size of the emitting region at increasing frequencies. Unusually high superluminal velocities, like those observed in souces like 0235+165 (Fan, Xie, & Wen 1996), could significantly lessen these lower mass limits (see RSV). The upper limit to the linear extent of the shocked region in the jet of the blazar is

$$x \approx 2 \sin^{-1} \theta R_{\rm e} \frac{D_{\rm s}}{D_{\rm d}}, \qquad (14)$$

where θ is the angle of the jet with the line of sight. From the small angles usually assumed for compact blazars like PKS 0537–441 this length can be as large as 20 $R_{\rm e}$. For a reasonable range of masses this is in good agreement with the values expected from parsec-scale shocked jet models (Qian et al. 1991; Marscher 1992; Romero et al. 1995a).

We see from the estimates shown in Table 1 that if the mass function $N(M) \propto M^{-2}$ were appropriate for microlenses in the foreground galaxy with masses in the $10^{-4} - 1\ M_\odot$ range, one month of optical monitoring of the source would report about fifty microlensing events in the case of the propagation of a thin shock with $v_{\rm app} \sim 3.5c$. Under the same conditions, four events should be observable at radio frequencies. The number of events predicted at different mass intervals depends on the mass function index. For instance, for $N(M) \propto M^{-2}$ the number of events increases by a factor $10^{\frac{1}{2}}$ when one goes from a mass interval to the following lower one. For a general mass function $N(M) \propto M^{-\alpha}$, this factor would be $10^{\alpha - \frac{3}{2}}$. Then, we expect that the detected events can provide important clues about the mass function of the intervening galaxy and the corresponding low mass limit. The masses of the dark objects detected by gravitational microlensing in our own galaxy fall in the range of those accessible to radio searches in PKS 0537–441. This might give place to an interesting comparative experiment. Multifrequency observations would facilitate the identification of the real microlensing events by means of the expected frequency dependence of the time scales in the case of intrinsic variations. Particularly, one should not expect strong intrinsic variability (amplitudes larger than 1.4) at decimeter wavelengths occurring on time scales of a few hours. The brightness temperatures implied for such variability cannot be reconciled with the inverse Compton limit without assuming bulk motions with Lorentz factors larger than 100 in the source, even under the most optimistic assumptions. Such extremely high Lorentz factors seem to be quite unrealistic (e.g., Witzel et al. 1988; Ghisellini et al. 1993; Fan et al. 1996). If we observe a symmetric outburst over a time scale of $\sim 10^4 - 10^5$ s at a decimeter wavelength and simultaneous outbursts on similar or smaller time scales at shorter wavelengths we shall have a serious candidate for a microlensing event. Extrinsic variability produced by refractive interestellar scintillation and extreme scattering events can be distinguished from microlensing variability because they cannot be correlated with variability at optical frequencies.

We conclude that the superluminal gravitational microlensing scenario for PKS 0537–441 is promising enough to justify a search for low mass objects in the foreground galaxy. Such a search should be carried out not only in optical bands but also at radio wavelengths. A few months of observations might produce interesting results.

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