mation. The estimates include not only the masses but also the interaction of the dark matter that may be investigated using this process. The Lynden-Bell violent relaxation also may play a nontrivial role in this interaction, [4, 17]. See also new results on the role of mergings in galaxy evolution in [18].

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INTENSITY CONTOURS STRUCTURE OF THE SOURCE IMAGE IN THE GRAVITATIONAL FIELDS OF GALAXY AND MICROLENS

In the approximation of Sobolev method and paraxial optics, analysis of the focusing effect of a complex gravitational lens formed by the gravitational fields of a macrolens - galaxy and a microlens – star was performed. The problem solving at an arbitrary location of the microlens in the line of the path source - macrolens – observer was found. Intensity contours of images were constructed and magnification factor of a complex lens was calculated. It is shown that the microlens has the most influence on the focusing effect when it is located on the path macrolens - observer.

У наближеннях методів Соболева і параксіальної оптики проведено аналіз ефекту фокусування складної гравітаційної лінзи, утвореної полями тяжіння макролінзи – галактики і мікролінзи – зірки. Знайдено рішення задачі при довільному розташуванні мікролінзи уздовж траси джерело – макролінза – спостерігач. Побудовано ізофоти зображень і пораховано коефіцієнт підсилення складної лінзи. Показано, що найбільший вплив на ефект фокусування мікролінза чинить у тому випадку, коли вона знаходиться на ділянці траси макролінза - спостерігач.

Introduction. In problems connected with the radiation propagation in near space and cosmic space, there are situations when medium inhomogeneities have several spatial scales. It can be inhomogeneities in the Earth atmosphere, solar corona, pulsars in globular clusters. In all these cases, it must be considered both rays refraction caused by large-scale structures and scattering of waves by small-scale inhomogeneities. Another example is the focusing of quasar radiation in the gravitational field of a massive galaxy inside of which microlenses are located. Within the framework of the method of thin phase screen, combined effect of gravitational fields of microlens and all galaxies on the source radiation can be accounted by introduction two independent phase correctors. One of them is connected to a microlens and the second one to the macrolens. It is assumed that the two phase correctors can be combined into one. This approximation does not take into account the effect of gravitational field of the global structure on the "local" radiation focusing in the microlens gravitational field. The presence of different scales in the focusing properties of systems may lead to effects which cannot be tracked in the approximation of the combined phase screens. In the present work, the problem has been solved when two screens are not combined in one plane and are separated by some distance. And small-scale inhomogeneities randomly located in the line of the radiation propagation path.

Analysis of radiation focusing as the approximation of Sobolev method. At the analysis of radiation focusing in the gravitational field of the galaxy with microlens, two cases were considered. At first, solution was obtained for the case when the microlens is located between source and galaxy mass centre, and then when the microlens is between galaxy centre and observer. The radiation propagation through the gravitational field of the galaxy and the microlenses is shown schematically on fig. 1. In present consideration, microlens is situated between the galaxy center and the observer.

Superpose the coordinate system origin with the centre of mass of a macrolens, and dispose the oz axis through the point of observation P. Extended source of radiation S is given in the plane $z=-Z_s$. Microlens is located in the plane $z=Z_m$ at some distance $\vec{P}_m$ from the OZ axis.

Sobolev method allows to obtain a solution of the wave equation written for a medium with a refractive index in a form of Kirchhoff formula for free space. At this, a field in an arbitrary point of space is expressed through the initial distribution of field over the surface surrounding the point [1].

As the approximation of Sobolev method and paraxial optics, the propagation path of radiation $-Z_s \le z \le Z_p$ is divided into three regions: 1 - source - macrolens $\left(-Z_s \le z \le 0\right)$; 2 - macrolens - microlens $(0 \le z \le Z_m)$; 3 - microlens - observer $\left(Z_m \le z \le Z_p\right)$.

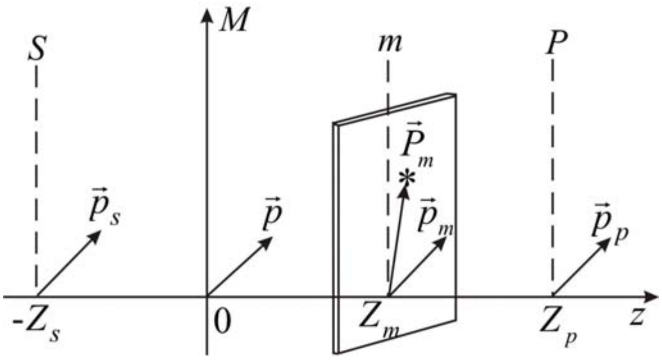


Fig. 1. Relative position of radiation source S, macrolens GL and observer. P.

Similar procedure is performed for the case when microlens is located between the source and the galaxy mass centre. Such dividing into stages will allow to avoid the cases of ray crossing for each region. This opens up the way to create the desired solution of field by successive transfer of the field value $U(z,\vec{p})$ with the screen on the screen [2].

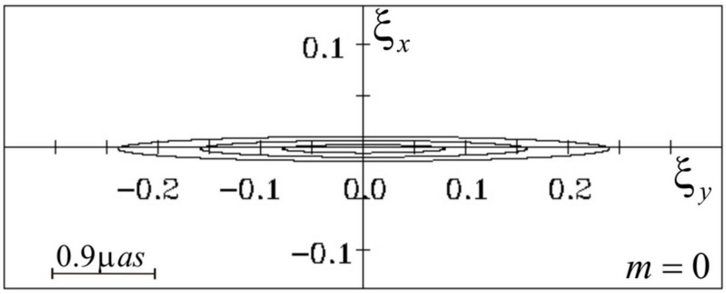


Fig. 2. Distribution of the intensity in a source macro image unperturbed by microlens (values on the axes multiplied by 10^{-5}).

Also, we can obtain for each region the mutual-coherence function (MCF) which is defined as statistically average from the product of fields in the mutually spaced points of the plane:

$$\Gamma(0;\vec{p}',\vec{p}'') = < U(0,\vec{p}')U^*(0,\vec{p}'') > \approx \frac{k^2}{4\pi^2(0-Z_s)^2}\iint d\vec{p}_s' d\vec{p}_s'' \,\Gamma_s(Z_s;\vec{p}_s',\vec{p}_s'')\exp\left\{ik\left(\psi\left(\vec{p}_s',\vec{p}'\right)-\psi\left(\vec{p}_s'',\vec{p}''\right)\right)\right\}.$$

Where $\Gamma_s(Z_s;\vec{p}_s',\vec{p}_s'')$ is the initial MCF in the plane $z = Z_s$, which in the superposed points is by definition equal: $< U_s(Z_s,\vec{p}_s')U_s^*(Z_s,\vec{p}_s'') >$. $\psi(\vec{p}_s,\vec{p})$ is eikonal calculated by integration of the medium refractive index in the line of the direct ray connecting points $(Z_s,\vec{p}_s)$ and $(0,\vec{p})$. Thereby, MCF in the point of observation can be obtained by successive transfer solution with the plane on the plane [2], provided that there is a medium with index of refraction between them.

The source model is specified in a form of incoherently radiating surface elements:

$$< U_s(\vec{p}_s')U_s^*(\vec{p}_s'') > = I_s(\vec{p}_s')\delta(\vec{p}_s' - \vec{p}_s''),$$

where $I_s(\vec{p}_s)$ is a deterministic model law of intensity distribution over a surface. To further simplify calculations, we consider the Gaussian distribution law [2]:

$$I_s(\vec{p}_s) = \left(I_0 / 2\pi R_s^2\right)\cdot\exp\left\{-\left(\vec{p}_s - \vec{P}_s\right)^2 / 2R_s^2\right\},$$

where $\vec{P}_s$ is the offset from the centre of brightness distribution, I_0 is the intensity of the whole source surface, and R_s is the effective radius of the source.

MCF in a microlens plane should be noted separately. In solving the problem we take into account that effective influence of a microlens gravitational field on propagating radiation occurs within a region that is small as compared to the galaxy dimension. Therefore the microlens can be considered approximately as a relatively "thin" phase corrector (microcorrector) embedded in the extended "environment" of the galaxy. An additional phase incursion due to the microlens gravitational field can be taken into account at the microcorrector output, if we write the microcorrector transmission function [2].

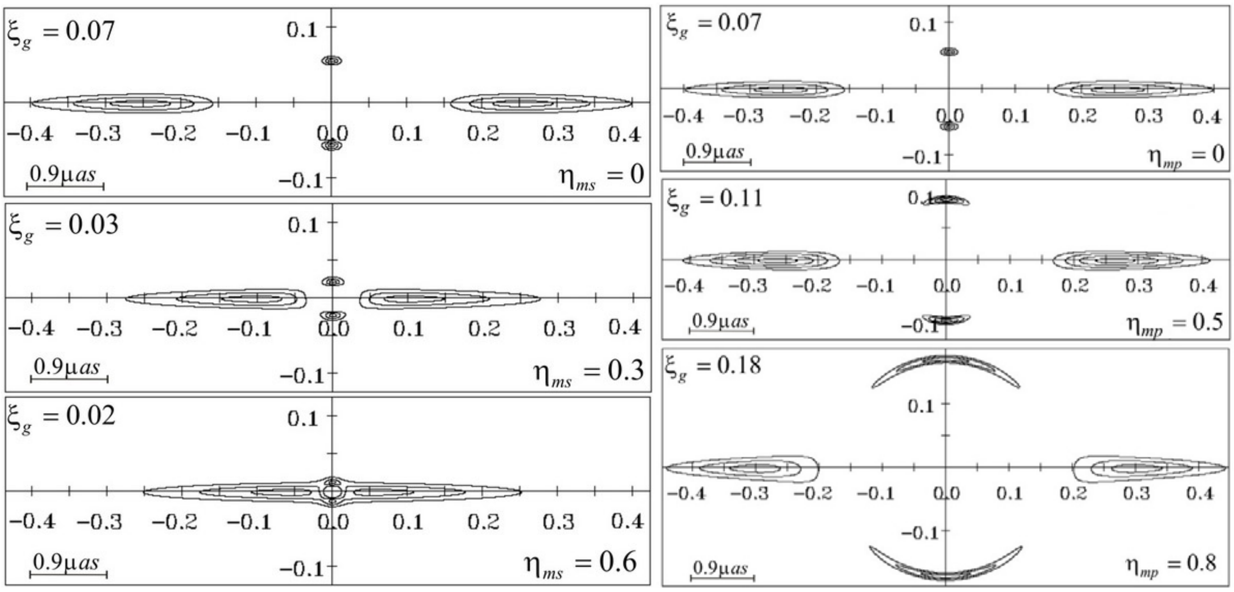
Knowing MCF in the observation plane one can calculate the average intensity in the observation point:

$$I_p(\vec{\psi}) = \left(k^2/4\pi^2\right)\cdot\int\limits_{-\infty}^{\infty} d\vec{\rho}_p\,\Gamma\left(Z_p;\vec{\rho}_p\right)\exp\left\{i\,k\,\vec{\psi}\,\vec{\rho}_p\right\}$$

and the magnification factor of image brightness:

$$q(\vec{\psi}_s,\vec{\psi}_m) = \left(\left(Z_p + Z_s\right)^2/I_0\right)\cdot\int\limits_{-\infty}^{\infty} I_p\left(\vec{\psi};\vec{\psi}_s,\vec{\psi}_m\right)d\vec{\psi}$$

Numerical simulation. For the numerical analysis, it is necessary to specify the parameters of models. As an example, we chose the gravitational lens systems Q2237+0305 ("The Einstein Cross") [3-5]. The radiation source in the system is a quasar with redshift $z_s \approx 1.69$. The macrolens is a massive spiral galaxy which has redshift $z_d \approx 0.039$. The galaxy consists of a compact spherical nucleus and an extended disk [4]. Four images are formed in the form of a cross under the influence of gravitational field of a galaxy. These images are situated in immediate proximity to galaxy center. To simplify, we confine to only one spherical component of the mass connected with the galaxy nucleus.



a) b)

Fig. 3. Distribution of the intensity in visible image of a source for different positions of a microlens between: a) - source and galaxy centre; b) - galaxy centre and observer (values on the axes multiplied by 10–5).

The angular size of the radiation source is $\Psi_0 = 0.04\mu as$ [3]. The unperturbed shift of the source brightness center $\vec{\psi}_s$ for Q2237+0305 at different model approximation of galaxy was estimated as $0''.1 \div 0''.01$ [5]. We chose the most maximum shift of source for the results visualization $\psi_s = 0''.1$.

Angular radius of the galaxy Einstein ring estimated from observational data: $\Psi_G \approx 0''.9$ [4]. According to observed data, microlensing effect is caused by bodies with a relatively "small" masses [6]. Choosing $M_g \approx 0.01 M_\odot$, we obtain value of angular radius of the microlens Einstein ring, located in the galaxy plane: $\Psi_g(0) \approx 7\,\mu as\sqrt{M_g/M_\odot} \approx 0.7\,\mu as$ [3].

The interaction of the gravitational fields of micro- and macro lenses will be demonstrated by example of deformation of the images isophots. Spherically symmetric macrolens creates two macro images for selected shift of source brightness.

We considered the microlens influence only on first - "direct" macro image. The results are given in relative units: $\vec{\xi} = \vec{\psi}/\Psi_G$, $\xi_g = \Psi_g/\Psi_G$. The structure of the intensity contours of macro images unperturbed by microlens is presented on fig. 2. That means that we can see one of macro images created only by the gravitational field of galaxy.

In the sequel, the position of microlens in a plane $z = -Z_m$ will be projected into the macro image centre at the different distances from the galaxy center. Intensity contours of images visible from the observation point at various microlens positions between the centre galaxy and the source is shown on fig. 3a. ($\eta_{ms} = Z_m/Z_s$). One can see that the microlens effect on unperturbed macro image (fig.2) is appeared in the split into four micro images. These micro images are formed near the microlens Einstein ring. The microlens influence is practically disappeared when microlens approaches the source. It is the effect of macro images.

We can obtain the most valuable information about focusing effect from magnification factor of the whole lens. The dependence of the magnification factor of a complex system on different microlens position into a galaxy is presented on fig. 4. Values on the axis are normalized to the magnification factor of macro images created by galaxy. From this figure we noticed that the microlens influence is almost perceptible when microlens approaches a source.

We can obtain the most valuable information about focusing effect from magnification factor of the whole lens. The dependence of the magnification factor of a complex system on different microlens position into a galaxy is presented on fig. 4. Values on the axis are normalized to the magnification factor of macro images created by galaxy. From this figure we noticed that the microlens influence is almost perceptible when microlens approaches a source.

The results for second case is illustrated on fig. 3b when microlens is located between the macrolens centre and observer ($\eta_{mp} = Z_m / Z_p$). Again, microlens is placed directly in the plane passing through the center of the galaxy on the first graph. And then microlens is removed in the direction to the observer. From this figure we noticed that isophots structure is changed besides splitting of macro image. Isophots structure are approached the image of the microlens Einstein ring closer and closer with increasing Z_m .But when we shift the microlens in the direction of the observer microlens effect on the total magnification becomes more and more evident. This circumstance is also confirmed by the structure of the intensity contours what it's already seen on fig 3b. By moving the microlens, we projected it on the micro image centre. In this case, microlens influence is maximum. The magnification factor of microlens can be estimated as ratio of solid angle of micro image and source [7]: $q_m \approx \Psi_g / \sqrt{q_1}\Psi_0$. It's necessary to consider the value q_m as maximum value of magnification by microlens.

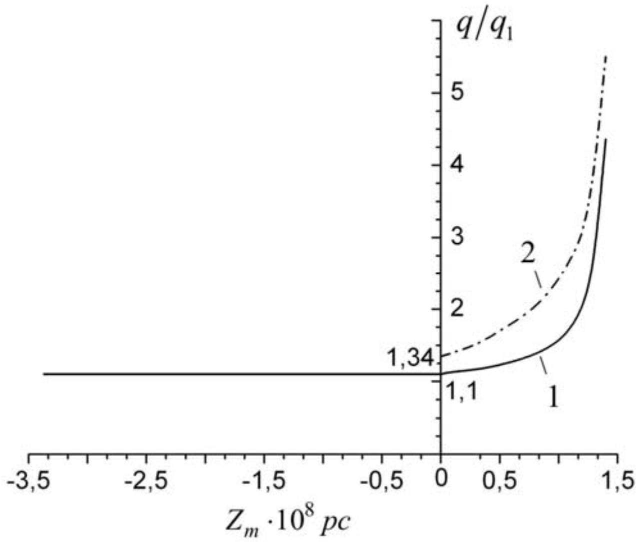


Fig. 4. Magnification factor of complex lens (1) and magnification factor of microlens (2), normalized to magnification factor of macro image

Conclusion. Based on the analysis and results of numerical estimation, we conclude that the degree of influence of the microlens-stars on the characteristics of a complex system depends on the microlens position inside macrolens - galaxy. The microlens has the most influence on the focusing effect when it is located on the path macrolens - observer. This fact must be taken into account at the processing of observational data of the microlensing effect.

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ДИНАМИКА АТМОСФЕРЫ АКТИВНОЙ ОБЛАСТИ ВО ВРЕМЯ ДВУХ ХРОМОСФЕРНЫХ ВЫБРОСОВ

Исследовано поле лучевых скоростей движения плазмы нижней атмосферы на участке одной из первых активных областей NOAA 11024 южного полушария Солнца нового 24-го цикла солнечной активности во время двух хромосферных выбросов. Наблюдения были проведены 4 июля 2009 г. на франко-итальянском телескопе THEMIS (Испания, о. Тенерифе). Скорость подъема движения хромосферного вещества в первом выбросе достигала - 44 км/с, а во втором – -75 км/с.

The line-of-sight velocity field of plasma motion in the lower atmosphere of one of the first the active region NOAA 11024 at the new solar activity cycle onset phase during two chromospheric ejections are investigated. Observations on July 4, 2009 with the Franco-Italian telescope THEMIS (Spain, Tenerife) were conducted. The chromospheric line-of-sight velocities in the first surge reached - 44 km /s, while the second – -75 km/s.