CONTRIBUTION OF TOPOLOGICAL DEFECTS TO THE VARIABILITY AND STRUCTURE OF EXTRAGALACTIC SOURCES OF LIGHT

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ABSTRACT. We discuss the mechanism of the fast extrinsic variability of the compact extragalactic sources of electromagnetic radiation due to the diffraction on cosmic strings. The multiple string intervention could give rise both to observable variability and considerable increase in observable luminosity of quasars. The light curves due to the intervention of strings are obtained.

Key words: dark matter, gravitational lensing.

The existence of cosmological strings with a mass per unit length about 10^{23} g/cm was suggested more than 15 years ago (Zel'dovich 1980). Now there are indications that intermediate cosmic strings, associated with cosmological phase transitions taken place after the 'Grand unification' symmetry breaking and before the electroweak symmetry breaking, possibly exist at our days (Ossipov 1995).

The clouds of the strings of different mass densities, maybe associated with ordinary matter, can lens the light of quasars and galactic nuclei. When the sizes of closed string loops are sufficiently large (Ossipov 1996)

$$R \gg \sqrt{\frac{D_{LS} \cdot D_{OS}}{(D_{LS} + D_{OS})} \cdot \lambda \cdot \frac{1}{\sin^2 \varphi}}. \qquad (1)$$

the gravitational microlensing (lensing without resolution of images) by strings can be easily distinguished from the microlensing by ordinary matter.

The strings split the light geodesic producing a number of unresolved images. It is necessary to calculate the luminosity curves of the total observable intensity of quasars in wave optics approximation despite the fact that at cosmological distances the 'zone excess number' (Ossipov 1995)

$$N = \frac{1}{2}\delta^2 \frac{D_{OS} \cdot D_{LS}}{D_{OS} + D_{LS}} \cdot \frac{1}{\lambda} \sin^2 \varphi \qquad (2)$$

is considerably bigger than 1. (For notation see Fig. 1. φ is the angle between the string and the line-of-sight.)

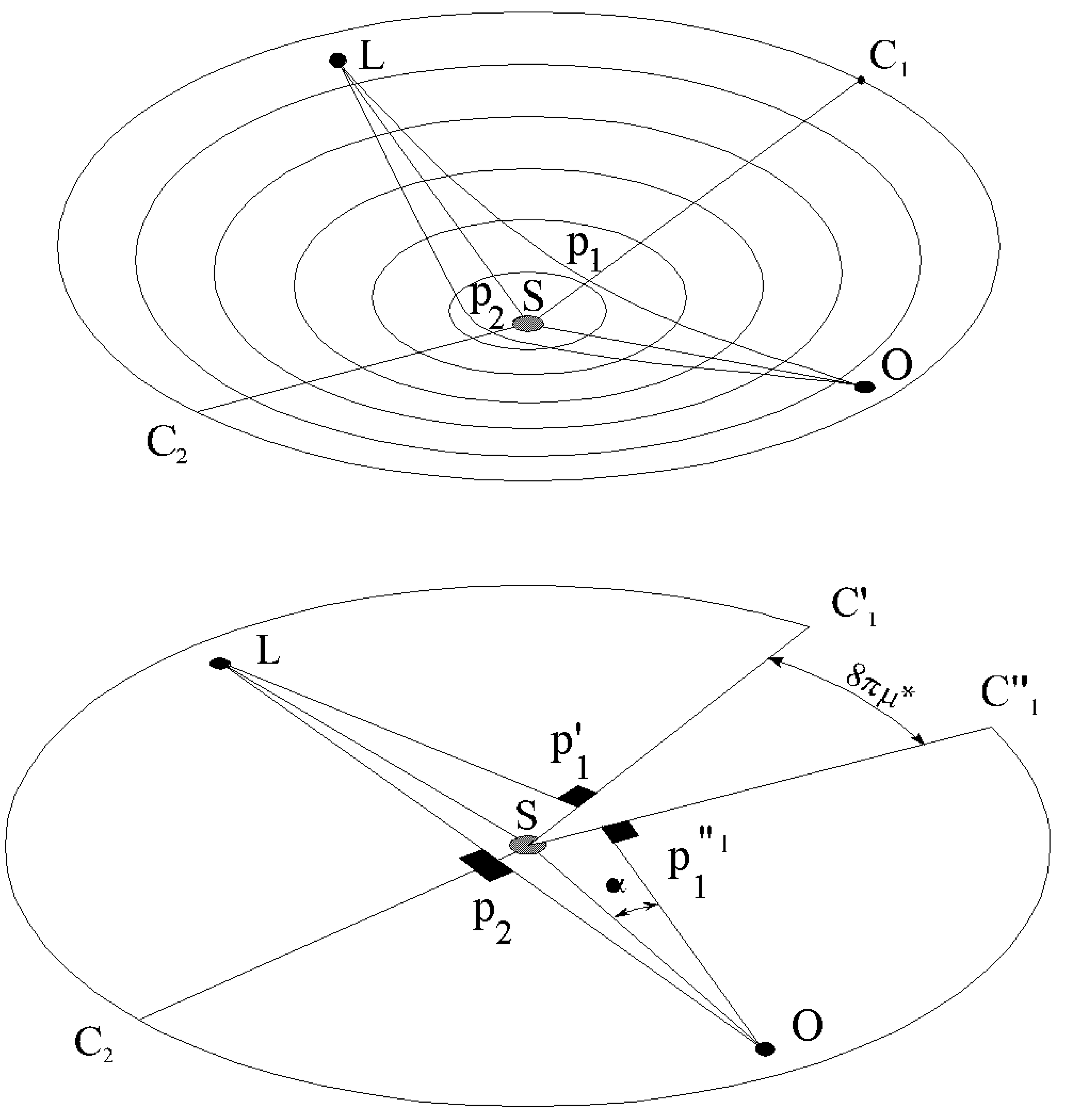

Figure 1. Embedding of a two-dimensional projection of the space around a string — surface perpendicular to the string — in a three-dimensional flat space, together with a planar unfolding of this projection. The section for the unfolding is made along the straight line SC, perpendicular to the straight (geodesic) line Lp_1O. When the string (S) lies near the line of sight, the star (L) and the observer (O) are connected by 2 minimum geodesics: Lp_1O and Lp_2O. These geodesics give two images of the lensed star which are formed by electromagnetic waves.

When $N \gg 1$ the partial intensities of the images, connected with each geodesic, are almost equal and constant. However the appearance (disappearance) of images should be described in the framework of the Fresnel diffraction problem.

When there are N strings near the line of sight from the observer to the point-like source of light, we can see M images ($N+1 \leq M \leq 2N$) randomly distributed over some solid angle. The motion of strings perpendicular to the line of sight changes the number of images giving rise to the variability of the observable luminosity of the intrinsically stable light source. We may distinguish two mechanisms of variability events with different variability curves.

First type mechanism . The variability caused by the appearance or disappearance of a geodesic. The corresponding variability curve are shown in Fig. 2a,b. The monochromatic curve is the same as in the Fresnel diffraction problem for the half-plane absorbing screen.

Second type mechanism (Fig. 2c,d). Interference caused by 'coincidental' proximity of lengths of two geodesics. We observe it when the difference between two geodesic lengths is of the size of the wave packet. The curve is well known in radio interferometer techniques. The finite angular size of the light source diminishes the amplitude of oscillations.

It is quite evident that the individual variability events may overlap. The typical time scales of variability events can be found in the article by Ossipov (1996).

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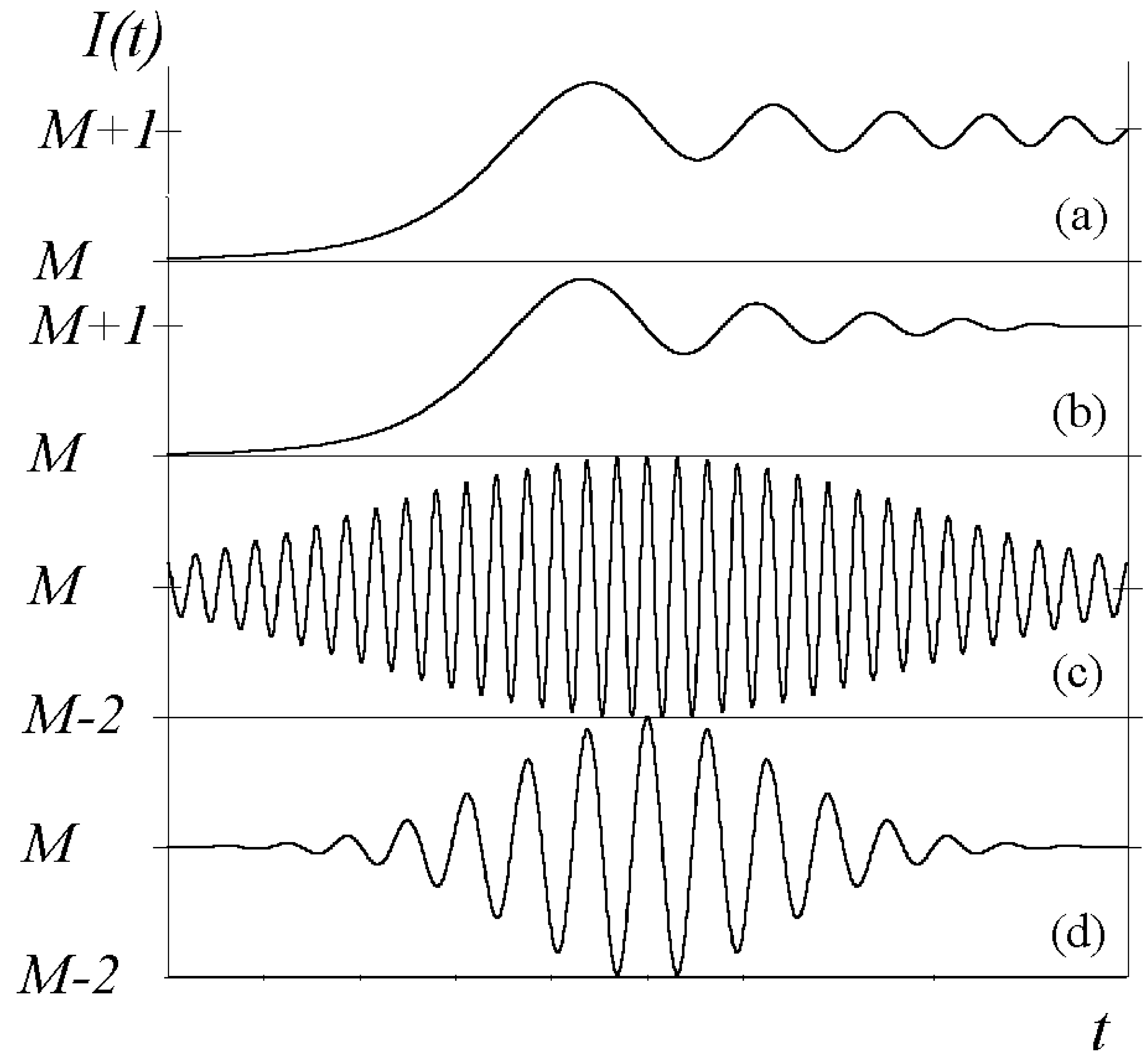

Figure 2. Two types of the luminosity variability curves for a point like source. (a) first type monochromatic curve. (b) first type curve for the spectrometric band of 20%. (c) second type curve for the spectrometric band of 5%. (d) second type curve for the spectrometric band of 20%.

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