GRAVITATIONAL WAVES GENERATED BY GLOBULAR CLUSTER SYSTEMS COLLAPSE

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The hypothesis –raised and discussed in [1]– that the source of AGN fueling can be, at least in elliptical galaxies, stars belonging to a dense stellar environment formed by globular clusters frictionally decayed and tidally destroyed by the gravitational field of central black hole (b.h.), is strongly supported in [2]. The quantity of star mass swallowed by the b.h. and its time rate seem at all compatible with those needed to justify the intensity and time characteristics of galactic nuclei activity (see also [3], [4], [5]).

In this short report we give a preliminary estimate of the number of gravitational impulses per year that the orbiting gravitational antenna LISA (at present under development by ESA) should detect. They are emitted by the stars falling into the b.h. whose mass, $M(t)$, and accreting rate per unit mass, $\dot{m}$, are given by the mentioned model (see [2], [4]).

We make the following assumptions: i) all the stars fall *radially* into the b.h.; ii) all such stars have $R = R_\odot$, and $m = M_\odot$. We know that a point mass m in a radial free fall into a b.h. of mass M, emits gravitational waves in form of an impulse with a well defined amplitude and spectrum (see [6]).

Moreover if a star has a radius very small compared with the wavelength of the gravitational waves emitted, then this star can be treated as a point mass. Hence destructive interference phenomena can be neglected (see [7]) and the amplitude of the emitted impulse is $A \sim 0.49(Gm/c^2)/d$ where d is the distance between the b.h. and the observer. Furthermore the detector LISA has the lowest amplitude limit $A_{min} \sim 10^{-23}$ in the frequency range

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$10^{-3} \div 10^{-2}$Hz. Consequently a source has to satisfy some conditions to be detected: i) it must be close enough for the impulse amplitude be $A > A_{min}$; ii) the spectrum of the impulse has to be peaked inside the frequency range above; iii) there must be no destructive interferences. These conditions involve the b.h. mass M and its distance (see [2] and [8] for more details).

Thus, considering *all* possible sources, integrating their contribution over all red-shifts between $z = 0$ and $z = \hat{z}$, $\hat{z}$ being the red-shift corresponding to the maximum distance below which $A > A_{min}$, we have the number of impulses per year that LISA should detect:

$$N = \int_0^{\hat{z}} \Omega(z) n(z) \Gamma(z) dz. \tag{1}$$

In the integral (1), $n(z)$ is the density of galaxies at red-shift z that we presume they have a central b.h., $\Gamma(z)dz$ is the volume element and $\Omega(z)$ is equal to $\dot{m}$ if the conditions above are satisfied (null otherwise). Considering $z = (2/3H_0t)^{2/3} - 1$ (flat universe) and adopting $n(0) = 0.1$ Mpc^{-3} we obtain the result reported in fig. 1 in which the number of impulses detected per year depends on the value of the Hubble constant and on the red-shift of galaxy formation z_f. This latter represents the origin of time by which our AGN fueling hypothesis starts to work.

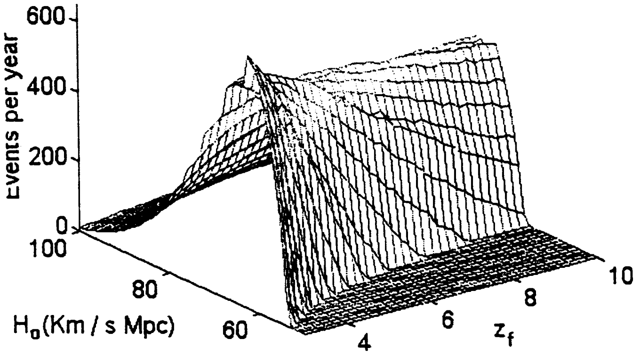

Figure 1. Number of impulses per year that LISA should detect as a function of H_0 and of the red-shift of galaxy formation, z_f.

References

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