L.N.L. - I.N.F.N. (REP) 68 / 92

THE EXTRA GALACTIC SOURCES OF GRAVITATIONAL WAVES REACHABLE WITH THE PRESENT GENERATION OF ANTENNAS

M. Cerdonio°, P. Fortini*, A. Ortolan*, S. Vitale°
I.N.F.N. Laboratori Nazionali di Legnaro - Collaborazione AURIGA

° *Department of Physics, University of Trento and I.N.F.N. Gruppo collegato di Trento, I-38050 Povo (Tn), Italy*

* *Department of Physics, University of Ferrara and I.N.F.N. Sezione di Ferrara, via Paradiso, 12 I-44100 Ferrara, Italy*

A cura del servizio
Documentazione dei
L.N.L.

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Massimo Cerdonio* **Pierluigi fortini#** **Antonello Ortolan#**
and **Stefano Vitale***

INFN *Laboratori Nazionali di Legnaro* - AURIGA Collaboration
Via Romea 4, I-35020 Legnaro, Padova, Italy

Abstract A list is given of the closeby galaxies, which are in range for the detection of gravitational wave burst by the ultracryogenic antennae under construction. Their distribution in the sky is also noticed and commented.

The ultracryogenic gravitational wave antennae NAUTILUS and AURIGA will be soon operating in coincidence with a sensitivity to "standard" gravitational wave pulses, as those presumably produced in supernova events and NS-NS collapses, $h_{\min} \approx 3\times10^{-20}$ for pulses of central frequency $500 \leq \nu_p \leq 1500$ Hz and few *ms* duration. The antennae will also be able to detect gravitational wave quasi-periodic trains, as those predicted to be generated by newborn pulsars, at $h \approx 10^{-23}$, if the train will keep its frequency in the antenna bandwidth for a few hours. The maximum distance at which such events shall occur in order to be detected by the antennae at a level $h_s \approx 3\times h_{\min}$ is easily calculated, assuming the burst to be a "standard" pulse, to be about 5 Mpc when one requests that the total burst energy at the source be $\Delta E \leq 0.1 M_O c^2$. It is of some interest to look into the question of which would actually be the potential sources, how they are distributed in the sky and what may be the event rate. In the given range

* Department of Physics, University of Trento and INFN Gruppo Collegato di Trento, I-38050 Povo, Trento, Italy.

Department of Physics, University of Ferrara and INFN Sezione di Ferrara, via Paradiso 12, I-44100 Ferrara, Italy.

we find 13 galaxies with masses larger than 1/10 of that of Galaxy, Table I. Among them we notice M31 (Andromeda) and M83 which showed 5 supernovae since 1932. The total mass is more than 10 times that of the Galaxy, Fig. 1, and so we can naively expect that the event rate will accordingly increase in respect to that of the Galaxy alone.

Table I

Object	Mass ($10^{11} M_\odot$)	Distance Mpc	ε_{min} $M_\odot c^2$
Galactic Center	0.7	0.01	5×10^{-7}
LMC	0.1	0.05	1.3×10^{-5}
M31	2.3	0.67	2.3×10^{-3}
M33	0.13	0.73	2.7×10^{-3}
NGC205	0.08	0.64	2.1×10^{-3}
M81	0.54	1.4	1.0×10^{-2}
NGC253	0.74	3.0	4.6×10^{-2}
Maffei I	~2.1	3.6	6.6×10^{-2}
NGC4945	~2.3	4.0	8.0×10^{-2}
M83	~2.3	4.1	8.6×10^{-2}
NGC5128	~2.3	4.9	1.2×10^{-1}
M82	~1.5	5.2	1.4×10^{-1}
M101	~2.3	5.4	1.5×10^{-1}

The table has been compiled using the Nearby Galaxies Catalog (R.Brent Tully; Cambridge University Press (1988)). The symbol ~ means that masses have been evaluated comparing the absolute luminosity of galaxies with that of Andromeda.

It is also important to notice that, when ultracryogenic bars will reach the so called "quantum limit" $h_{min} \approx 3\times10^{-21}$, the same total mass will be observable for events of energies less than $\Delta E \approx 10^{-3} M_O c^2$.

Finally we come to an unexpected features of these "in range" galaxies, which may be of relevance in detection strategies. Let us first recall that an ultracryogenic bar has an antenna pattern, which is a

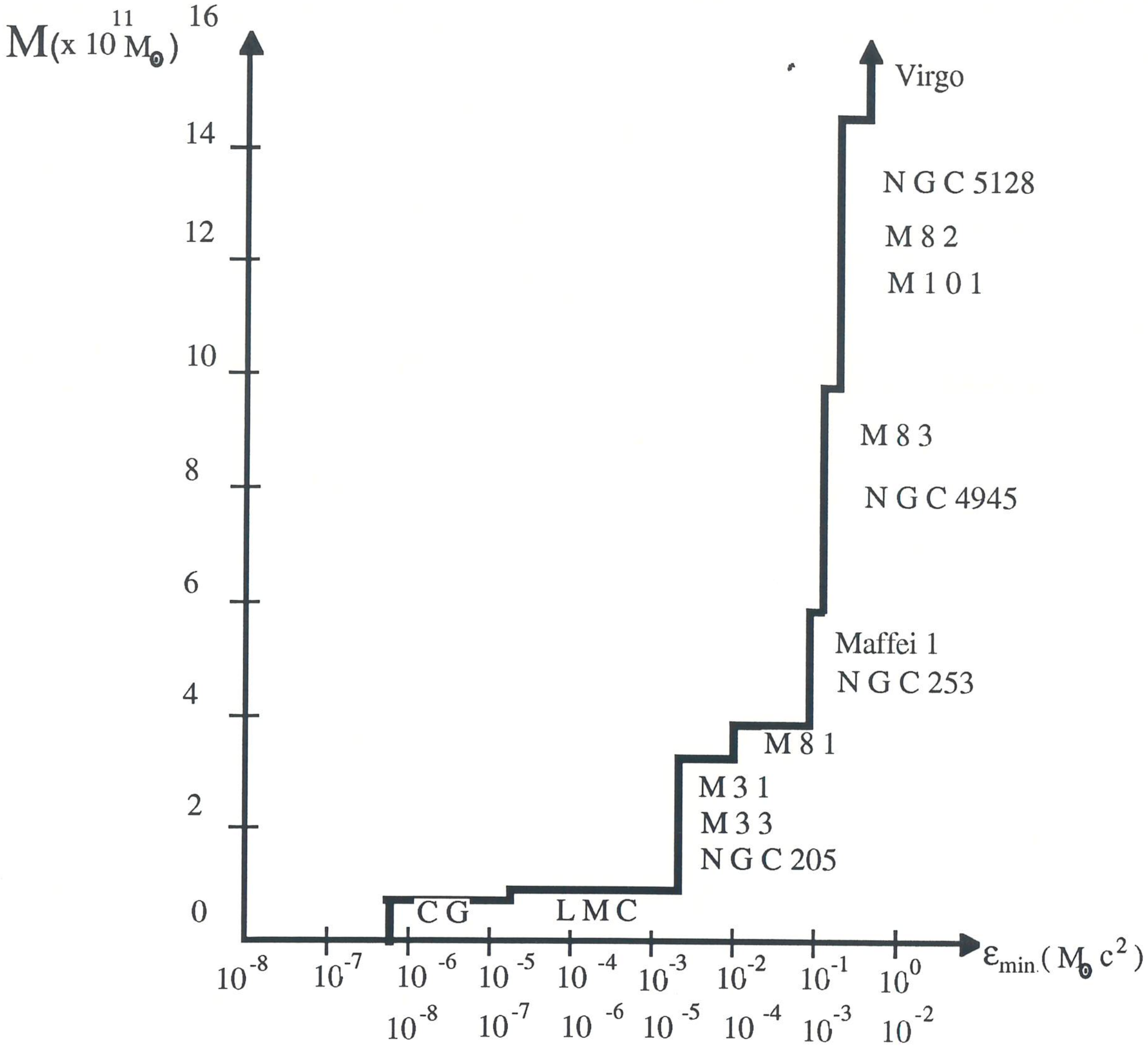

FIG. 1

The total mass observed by 3 antennae operating in coincidence, set at thresholsd of $2.7 \times h_{min}$ *(to get less than a false allarm per year because of pure thermal noise), as a function of the energy at release of a gravitational wave "standard" pulse.*

"$\cos^2 \vartheta$", with ϑ the angle from the median plane orthogonal to the bar axis. Then it can be seen that, if one requests the antenna pattern effect not to depress the signal captured by the antenna more than 20 %, almost all of 13 galaxies would be caught in the corresponding 50° angular aperture, if the antenna axis is kept orthogonal to a direction, which is very close to that of M83. Of course, to do this with an antenna bound to lay on the earth with its axis horizontal, one has to rotate the antenna during the day. This can be done with a suitable time dependence of the angular velocity, without risking damage due to torsional stresses in the suspension system of the antenna and possibly without introducing extra noise