Sky-localization of the LIGO-Virgo events as a test of possible polarization state of the gravitational waves

L. E. Fesik[1*], Yu. V. Baryshev[1†], V. V. Sokolov[2], G. Paturel[3]

[1]Saint-Petersburg State University, Russia

[2]Special Astrophysical Observatory of RAS, Nizhnij Arkhyz, Russia

[3]CRAL-Observatory de Lyon, Saint-Genis Laval, France

Detection of the first gravitational wave events GW150914, GW151226 and LVT151012 by Advanced LIGO antennas [1] has opened new possibility for study the fundamental physics of the gravitational interaction. Recent analysis [2] showed that the sky-circles of allowed positions of the GW sources for detected three LIGO events lies parallel to the supergalactic plane of the disc-like large scale structure known as Local Super-Cluster of galaxies having radius ~ 80 Mpc and thickness ~ 30 Mpc. This points to a possibility for reconsideration of distances to these GW sources, which will be tested soon during the second Advanced LIGO Observing Run.

In the situation when there is no electromagnetic identification of the GW event, an interpretation of the physics of the GW source is still uncertain. Even though the tens solar masses binary black holes coalescence at the distance 400 - 1000 Mpc is generally accepted [1], one should also test alternative possibilities which allowed by modern theories of the gravitational interaction [3], [4].

In this work we demonstrate that very general physical arguments allow us to distinguish between different polarization states predicted by the scalar-tensor gravitation theories. Actual localization of the source of GW on the sky by means of measurements of the arrival time delays between each pair of antennas together with relative amplitudes of the detected signals at each antenna can be used for determination the polarization state of the GW independent on the nature of the GW source. Hence the GW observations give new information about the physics of the gravitational interaction.

References

[1] Abbott B. et al., 2016a, Phys. Rev. X6, 041015

[2] Fesik L.E., Baryshev Yu.V., Sokolov V.V., Paturel G., 2017, (arXiv:1702.03440)

[3] Will C.M., 2014, Living Rev. Relativity, 17, 4

[4] Baryshev Yu.V., 2017, (arXiv:1702.02020)

*E-mail: lucia555@yandex.ru

†E-mail: yubaryshev@mail.ru