Can the wormhole spacetime be detected?

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The wormhole has the non-trivial topological structure in spacetime, which satisfies the Einsteins equation. It consists of a bridge connecting two asymptotically flat universes. The simplest model is given by the 'zero-length bridge connecting two Minkowski spacetimes eliminated by the same size spheres from each spacetime' [1]. The bridge plays the role of the short-cut, connecting two distant places. It means that if we travel through the wormhole, we can save the travel time comparing to the usual space-travel taking several years by detour way. In some case, travel through wormhole has the effect of the travel even faster than light. It, of course, really does not move faster than light. With these merits wormhole has various usage such as space travel or time travel. In fact, Thorne has shown the possibility of time machine by using the wormhole in 1988 [2].

As abovementioned, wormhole is a part of spacetime with a very special feature, we can ask questions about the wormhole existence whether it is a hypothetical object or an astrophysical reality. Even though there are problems to be solved, such as exotic matter and negative energy density constructing wormhole structure, and stability, it is sufficient worth discussing its existence. If wormholes exist in our universe, there are several ways to detect it: gravitational lensing, gravitational wave, and Hawking radiation.

Wormholes may be perturbed by exterior interactions, so the result will be stable or not. When it is stable, it can be observed by gravitational lensing or Hawking radiation. If it is unstable, it cannot be stay at any state and might be collapsed into black hole or other objects [3]. In this case, their effect on spacetime make arise the gravitational wave. If we already know the gravitational wave form for the specified event by wormhole, we can identify wormhole from the observed data.

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It is well known that the black hole radiate near event horizon like the blackbody radiation, which is called by the Hawking quantum radiation [4]. The Hawking radiation defines the Hawking temperature since it is thermal radiation. Recent research on the Hawking radiation is allowed near trapping horizon which is rather general concept for the dynamical case. From the transition probability of quantum tunneling effect at or near horizon, we can also derive the Hawking temperature.

In this presentation we check the possibility of Hawking radiation at trapping horizon of wormhole, and we get the spectrum power or traits in radiation for one of the evidences of wormhole existence. If Hawking radiation is confirmed, the Hawking temperature also can be defined like the thermal objects. Wormhole throat is doubly degenerate trapping horizon. There were a few trials to derive the temperature as positive or negative ones, according to the choice of the horizon [5]. The negative temperature is not so weird one, some negative temperature cases were already shown in specified physical situations. We will also discuss the relationship between the radiation energy sign and the temperature sign.

References

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