

Re: Black hole questions

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- *From:* Tom Roberts <tjroberts137@xxxxxxxxxxxxxx>
 - *Date:* Thu, 23 Nov 2006 01:52:39 GMT
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sal wrote:

On Wed, 22 Nov 2006 05:46:43 +0000, Tom Roberts wrote:

Wai Yu Wong wrote:

If so, how long does it take for the change of the black hole's gravity to reach the object?

The question does not make sense. In GR, gravity does not "propagate", and asking about speed or "how long it takes to get there" is inappropriate. Changes in the gravitational field(s) propagate with speed c .

I'm sorry; I don't understand. If the BH accelerates, then from the POV of a distant observer, its gravitational "field" changed (i.e., it moved, and that's a change).

Yes, that's a "change" as measured by the distant observer, but not necessarily a "change" in the rest "frame" of the BH itself.

In essence, the gravitational field surrounding the black hole moves with it as a single "entity". In particular, gravity does NOT "propagate out from the BH", the change in the field at point A depends ONLY on the values of the field near point A (i.e. within the past light cone of A).

NOTE: the above paragraphs are describing an approximation in which the BH is the only massive object around, and the observer is of negligible mass. Then in coordinates in which the BH is at rest, the field from the BH does not change but the observer moves; in coordinates in which the observer is at rest things must be the same, so the field from the BH in essence moves in "lockstep" with the BH.

A better way of discussing this is used below.

But that `_change_` must propagate from the BH out through the region

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surrounding its event horizon,

No. This is your mistake. Gravity does NOT "propagate out from the BH".

So, how does the information that the BH has accelerated — which takes the form of a change in the BH's gravitational field — ever get out to a place where we can detect it?

What happens is that the change in gravitation happens essentially independently of the acceleration of the black hole itself, at each and every point around the BH; the sum of all these "pulls the BH along", but note there is not really a causal relationship here as that phrase suggests — they all evolve TOGETHER.

In GR one must consider the Gestalt of the entire manifold (i.e. all places and all times). One cannot say "this mass pulled that black hole toward it", or "that black hole pulled this mass toward it", all one can really say is "the mass and black hole came together".

In GR, one cannot say "the gravitational field in my office is caused by the earth" — all one can say is that the earth and the field evolved together such that now in my office the field is thus-and-so.

BTW this is no different from any other field theory, such as Maxwell's equations. The E field near a point charge is not "caused" by the charge, nor is the charge "caused" by the structure of the field, they evolve independently in accordance with the field equations.

Tom Roberts

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