Israeli astrophysicists say neutron star collisions can help detect gravity waves

September 29 2011, by Bob Yirka

Neutron star collision. Image: NASA/Dana Berry

(PhysOrg.com) -- Neutron stars are what's left over from supernova explosions; so dense that protons and electrons are crushed together forming neutrons. The result is something relatively small in size, but incredibly dense. But what happens when two such stars capture one another in their respective gravity fields?

Ehud Nakar and Tsvi Piran, university professors in Israel, say they circle one anther until eventually colliding and unleashing an enormous amount of energy. In their paper published in *Nature*, the two describe how a simulation they've created shows that energy particles emitted from such an occurrence could reach speeds of one tenth to one half the speed of light. They also write that such an event could produce measureable gravity waves.

Gravity waves are something Einstein predicted as part of his theory of general relativity. Also described as the result of a space-time warp, gravity waves are thought to occur due to the existence of large mass objects. One analogy is a small stone placed upon a sheet of linen. Nothing happens. But when a large rock is placed on it instead, the linen bends around beneath it. The problem with trying to measure such gravity waves though, is that they dissipate as they move, just as do waves in water. Thus, waves that reach us after traveling billions of miles tend to be rather weak. Another problem is that they are one shot deals. Studying events in space is far more difficult than studying objects as they only last for a short while. Nakar and Piran believe that waves from a collision between two neutron stars would only be observable for a few months. Luckily, two new telescopes are currently being built to observe such phenomena; one in the US and one in the Netherlands.

In order to prove their theory, the duo needs to come up with some evidence to show that measurable energy from such a collision has reached the Earth before. And they think they have found it: RT 19870422, a transient object discovered in a previous study by astronomer Jeffrey Bower. Its properties seem to match those created in the simulation. But of course if it sent gravity waves our way they are long gone, thus looking towards the future, the two will have to find two neutron stars that are on the verge of colliding, then hope that they will be able to capture the results when it happens.

More information: Detectable radio flares following gravitational waves from mergers of binary neutron stars, *Nature* (2011) doi:10.1038/nature10365

Abstract

Mergers of neutron-star/neutron-star binaries are strong sources of gravitational waves. They can also launch subrelativistic and mildly relativistic outflows and are often assumed to be the sources of short γ-

ray bursts. An electromagnetic signature that persisted for weeks to months after the event would strengthen any future claim of a detection of gravitational waves10. Here we present results of calculations showing that the interaction of mildly relativistic outflows with the surrounding medium produces radio flares with peak emission at 1.4 gigahertz that persist at detectable (submillijansky) levels for weeks, out to a redshift of 0.1. Slower subrelativistic outflows produce flares detectable for years at 150 megahertz, as well as at 1.4 gigahertz, from slightly shorter distances. The radio transient RT 19870422 has the properties predicted by our model, and its most probable origin is the merger of a compact neutron-star/neutron-star binary. The lack of radio detections usually associated with short γ-ray bursts does not constrain the radio transients that we discuss here (from mildly relativistic and subrelativistic outflows) because short γ-ray burst redshifts are typically >0.1 and the appropriate timescales (longer than weeks) have not been sampled.