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Subject: Some thoughts about LIGO
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Tony,

There are some real questions in my mind about this project. I should say right away that it hasn't impinged on my thinking much. (That, in itself, may be significant.) As a result I'm not quite sure what frequency range this detector is sensitive to, what the cost is, or just how they arrived at a number like 3 detections per year. Still, I think the following points are pertinent.

1) When the effort to detect gravitational waves started it was clearly at the forefront of physical research (the "cutting edge" as we former students of W. Press like to say). Since then GR has passed numerous weak field tests designed to separate it from competing theories. More importantly, we have at least one system that has confirmed the quadrapole formula for the emission of gravitational waves. It is now clear, beyond a reasonable doubt, that gravitational waves exist and that we can calculate their emission rate from a system. Therefore this project is no longer at the forefront of research into gravity as a fundamental force. If it can be justified, it must be on the basis of its contribution to astronomy.

2) My impression is that LIGO will be sensitive to only to events such as core collapse events (SN), and the merger of stellar mass black holes and/or neutron stars. It cannot detect radiation from binaries that are not merging (because it lacks sufficient sensitivity at the appropriate wavelengths) and cannot detect radiation from more speculative occurrences (such as the merger of supermassive black holes) that would emit radiation with a characteristic frequency of a small fraction of a Hertz. The rates associated with the latter are unknown, but thought to be quite small. The former occurs rather often (although a counting rate of 3 per year seems suspiciously high). The thing is, we know supernovae occur. This project is worthwhile only if it can shed some *unique* light on supernovae core collapse.

3) It is tempting to compare this kind of project to efforts to do neutrino detection of supernovae. However, there are some striking differences. The neutrino detectors are part of experiments that have several different uses for particle physics. LIGO is not. The neutrino emission from a supernova is closely linked to the production of energy. It is impossible to imagine a SN with no neutrino emission, and the detection of neutrinos give us a quantitative measure of the core collapse. This can be compared to theoretical work on core collapse to give us some important constraints on the physics of SN. The gravitational wave emission from a SN is the result of an asymmetry in the collapse. This is an effect which has not yet been convincingly calculated from first principles. No one knows whether this would be an important constraint on the physics of SN, or just an irritating little detail that is hard to calculate, but of no fundamental importance. If you do get a detection rate for core collapse events then this constitutes some constraint on the number density of SN times the efficiency factor for the production of gravitational waves. The first number is not known too precisely. The second number is unknown. It's not clear what you would do once you knew it.

The bottom line (as I see it) is that this project is not worth big bucks if that money comes from the astronomy pot. It might be worth doing eventually if the theory of core collapse can be made to yield estimates for the gravitational wave emission and we discover that an observational check on the number would be interesting.

Cheers
Ethan