Proposal for the CAPITAL initiative: gravitational wave phenomenology

Rationale:

A historically remarkable revolution is about to happen in astronomy; we will for the first time use a different kind of light than electromagnetic waves to look at the universe: we will use gravitational waves. Some people have equated this development to Galileo first using a telescope to look at the sky. The National Science Foundation is Funding the construction of two gravitational wave telescopes, one of them in Livingston, Louisiana (the LIGO project). This is the largest project in the National Science Foundation. The instruments will be ready in 2002 and will achieve peak sensitivity in 2006-7.

Independently, the National Administration of Space and Aeronautics in the US and the European Space Agency in Europe are in preliminary stages of funding the construction of a space-based telescope of gravitational waves (the LISA project).

The emerging new science of gravitational wave astronomy is about to be born. Several groups in the country are attempting to be the among the first to reap the benefits of these new instruments. Among them, Penn State has recently been awarded a Physics Frontiers Center (PFC) initiative from the National Science Foundation for this purpose. It was publicly announced that Caltech will seek a similar initiative in the future.

Why LSU?

LSU has natural ties with the LIGO experiment. Not only one of the largest experimental groups collaborating in LIGO based at a University is at LSU (Giaime, González, Johnson), but the LIGO telescope is on LSU owned land, and LSU is one of the historical groups who pioneered gravitational waves in the US through Bill Hamilton. LSU has furthered its connection to the experiment by hiring a theorist (Pullin) through the Hearne Chair to set up a theoretical group related to LIGO. An assistant professor along these lines will also soon be recruited. Theoretical astrophysics is strong at LSU as well (Frank, Tohline).

Handling, processing and analyzing the data for the LIGO interferometer is a significant computational task. The interferometer puts out hundreds of channels at 16KHz and a few thousand extra channels at 2KHz. The real-time handling and first-cut analysis of the data can only realistically be probably only be achieved by teraflop-scale machines (depending on the sophistication of the analysis). LIGO will have its in-house computational capabilities, but will definitely benefit from all the help it can get. The project is clearly challenging enough as to push the boundaries of current IT state of the art. The kind of scientist interested in this line of work is mostly academic, and anecdotal evidence suggests that they will find themselves more at home at an academic institution like LSU than at a research lab like LIGO. It would be a unique opportunity to attract the top talent in this field to Louisiana. Right now the only in-house data analysis capability for LIGO is at the Beowulf cluster at Caltech. Its personnel is set and several talented young figures in the field are looking for positions.

On the other hand the numerical modelling of sources of gravitational radiation is also computationally intensive. The field was temporarily funded by an NSF Grand Challenge initiative until 1999. There is constant need of computational resources and support. Urgent needs are expertise in parallelization, adaptive mesh refinement techniques and visualization.

Having experimental and theoretical strengths already at LSU, and LIGO nearby makes the situation ripe for leveraging these resources into a nationwide leadership role with a modest investment, by adding to the effort a LIGO data analyst and some specifically targeted computer science people.

The proposal:

To develop a gravitational wave phenomenology group at LSU that could become the leading group nationally to interpret and handle the data produced by the LIGO and LISA interferometers. From the point of view of human resources, this could be accomplished by hiring a faculty member in physics doing data analysis, supplemented by a staff scientist position and a faculty member either in physics or computer science specializing in parallelization and visualization techniques. The infrastructure that is being considered by the CAPITAL initiative (a 1024 node Beowulf computer) will surely help, but the scientists could also leverage LIGOs own computational infrastructure in this effort.