

Proposal for a KITP program on: Interplay between numerical relativity and data analysis

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Suggested Organizers: Patrick Brady¹, Luis Lehner² and Saul Teukolsky³

1 Motivation

Searches for gravitational waves from coalescing compact binary systems rely on concrete knowledge of the waveform to achieve maximum sensitivity to these sources. With LIGO currently acquiring data at design sensitivity, an optimal matched filtering search could detect the gravitational waves from binary black hole coalescence out to several hundred Mpc. Direct observation of gravitational waves from these systems will have significant and far reaching consequences for both gravitational physics and astronomy.

To date, searches for gravitational waves from compact binary systems using data taken at LIGO, GEO and TAMA observatories have concentrated mostly on systems where theoretical templates are obtained via perturbative methods. For systems containing highly compact objects (like black holes and neutron stars) at their most dynamical stage (around the merger epoch), these methods cannot be considered a-priori to provide accurate representations of the gravitational waves generated by these systems. Nevertheless, these systems are expected to be among the strongest sources of gravitational waves and, based on event rate estimates, are likely to provide the first detections. To develop a complete picture of these systems will require difficult numerical simulations and a strong interplay between theorists and observers.

This interplay of numerical relativity and data analysis has been limited, to date, as each field concentrated energies in dealing with the formidable tasks each one had at hand. However, a number of developments have paved the way for stronger collaborations. In addition to the detectors taking data and operating at their design sensitivity:

- numerical simulations of orbiting black holes are becoming available (although these simulations only cover a restricted portion of the parameter space up to now);
- advances in data analysis techniques, spurred by the knowledge gained through searches using Post Newtonian templates, have singled out robust techniques for parameterizing templates and analyzing the data with them.

So, the time is ripe for progress at the interface between numerical relativity and gravitational-wave observing.

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Fostering further and stronger collaborations between researchers in disciplines related to the search for gravitational waves is a major goal of this workshop. We believe that a program of the sort proposed here would bring substantial rewards by fostering the type of interaction that cannot be achieved with informal discussions during a 2-3 day meeting.

2 Program length

We propose a program whose length is three weeks. This length is motivated by the importance of bringing key people together at the same time. A longer program would suffer from the heavy agenda members of the LIGO Scientific Collaboration have.

3 Commitment

Logistics A focused miniprogram is the best way to foster intense interaction and generate results in this field. Note that in Fall 2006 a two-day meeting at MIT illustrated how much is to be gained by bringing together researchers in these related fields. It was also clear, however, that a longer concentrated period of interaction would be very important in addition periodic short meetings on the subject. Such an extended meeting can only take place at the KITP. We would request that, if approved, our program be scheduled for Spring of 2008.

Suggested Key Participants: The following is a list of suggested participants for the program. We have contacted all of them with a draft of the proposal and all have expressed their strong support. Unless otherwise noted, all individuals have confirmed their interest in participating for at least 3 weeks.

- John Baker
- Beverly Berger
- Sukanta Bose
- Patrick Brady
- Duncan Brown
- Bernd Bruegman
- Alessandra Buonanno
- Jolien Creighton²
- Greg Cook
- Peter Diener
- Stephen Fairhurst
- Eanna Flannagan²
- John Friedman

- Erik Katsavounidis
- Badri Krishnan
- Luis Lehner
- Lee Lindblom
- Pablo Laguna
- Pedro Marronetti
- Eirini Messaritaki
- Ben Owen
- Denis Pollney
- Frans Pretorius
- Richard Price
- Jorge Pullin
- Luciano Rezzolla
- Peter Saulson²
- Bernard Schutz¹
- Deirdre Shoemaker
- Ulrich Sperhake
- Saul Teukolsky
- Manuel Tiglio
- Kip Thorne²
- Bernard Whiting

¹ can not come for more than two weeks; ² can not come for more than a few days.