

**Memorandum of Understanding**  
**between**  
**The Caltech Relativity Theory group (CaRT)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO) Project**  
**May 15, 1995**

The purpose of this Memorandum of Understanding is to establish and define a collaborative relationship between the Caltech Relativity Theory group (CaRT) and the Laser Interferometer Gravitational Wave Observatory (LIGO) Project. Both parties to this agreement share the joint goals of observing gravitational radiation and of using gravitational radiation as an astrophysical and fundamental physics probe. This agreement is intended to further these joint goals.

1. The Caltech Relativity Theory Group (CaRT) is a research group at Caltech, consisting of Professor Kip S. Thorne plus, typically, one senior visitor, two or three postdoctoral fellows, and four to six graduate students. CaRT's LIGO-related research, during the remainder of the 1990s, will focus primarily on theoretical issues related to gravitational radiation and LIGO, and will be funded primarily by research grants from NSF-Physics(PHY-9210038) and NSF-Astronomy (AST-9417371), and by Caltech funds associated with Thorne's Feynman Professorship.
2. The Laser Interferometer Gravitational-Wave Observatory (LIGO) Project is aimed at opening the field of gravitational-wave physics through the direct detection of gravitational waves. LIGO detectors will use laser interferometry to measure the distortions of the space between free masses induced by passing gravitational waves. The design, construction, and operation of LIGO is being carried out by scientists, engineers, and staff at the California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT). Caltech has prime responsibility for the project under the terms of a Cooperative Agreement<sup>1</sup> with the National Science Foundation (NSF). LIGO is a national facility for gravitational-wave research, providing opportunities for the broader scientific community to participate in detector development, observations and data analysis. LIGO welcomes the participation of outside scientists at any of these levels. LIGO is being constructed in a phased approach beginning with one three-interferometer detector system and evolving to a nine-interferometer configuration to enable simultaneous use by several gravitational-wave observation systems.
3. In entering into this Memorandum of Understanding, the LIGO Project will carry out its responsibilities following the requirements of the Cooperative Agreement<sup>1</sup>.

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1. Cooperative Agreement No. PHY-9210038 between the National Science Foundation, Washington, D.C. 20550 and the California Institute of Technology, Pasadena, CA 91125, dated May 1992.

4. The LIGO Project is responsible for obtaining NSF approval of all collaborative Memoranda of Understanding with international partners, or of those involving NSF costs exceeding \$100,000. All Memoranda of Understanding will be provided to NSF for their information.
5. Each party to this agreement continues to be responsible for all support of its staff including travel costs associated with the activities under this agreement. Exceptional support of travel by the other institution may be allowed for travel requested by that party.
6. This Memorandum of Understanding will remain in force until the parties mutually agree to terminate it. An annual Attachment will define specific activities if any, beyond those spelled out in this document, to be carried out during the following year.
7. Kip Thorne will serve as a liaison between LIGO and the international theoretical astrophysics and relativity communities. In this capacity, together with the LIGO Project and with those communities, he will identify LIGO-related research issues, he will facilitate study of these issues, and he will see that the results of this work are communicated to the LIGO Project in a timely and effective manner.
8. The Caltech Relativity Theory group, CaRT, will identify promising gravitational wave sources that LIGO might search for and study observationally, and will perform computations or estimates of the waveforms expected from those sources.
9. CaRT will carry out research on LIGO data analysis algorithms. In this work, CaRT will include one LIGO team member as a collaborator or consultant on each major data analysis development project and CaRT will maintain close contact with the LIGO CDS Group.
10. CaRT will do theoretical research on advanced detector issues.
11. CaRT will supply physics drivers (gravitational waveforms) and data analysis algorithms to the LIGO Project Integration Group for use in end-to-end modeling of LIGO.
12. CaRT will lead the effort on theoretical analyses of light scattering in the LIGO beam tube and the scattering noise that results from various possible baffle configurations, and will validate the effectiveness of the final baffle design.
13. CaRT will take on special tasks at the request of the LIGO Project Principal Investigator.
14. In all the areas included in this Memorandum, CaRT will communicate to the LIGO Project its research results and its interpretation of the implications for LIGO.
15. To enable CaRT to carry out these functions effectively,
  - a.) Thorne will receive LIGO weekly reports and can disseminate relevant portions to members of CaRT,
  - b.) other appropriate members of CaRT, to be determined by Thorne, will have access to

the following LIGO resources:

- i.) all LIGO reports, internal memos, and attendance at LIGO Group meetings;
- ii.) attendance at scheduled LIGO meetings;
- iii.) the usage of LIGO workstation cpus for the development of data analysis algorithms.
- iv.) sample gravity-wave data from the 40-meter prototype, for use in the development of data analysis algorithms.

Approved:

Barry Barish

Barry Barish  
LIGO Principal Investigator

May 17, 1995  
Date

Kip S. Thorne

Kip S. Thorne  
CaRT Principal Investigator

15 May 1995  
Date