

**Attachment Number E to the**  
**Memorandum of Understanding (LIGO-M950019-00-M)**  
**between the**  
**Caltech Relativity Group (CaRT)**  
**and the**  
**Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory**  
**August 15, 1999**

This Attachment to the Memorandum of Understanding LIGO-M950019-00-M covers the role of the Caltech Relativity Group (CaRT) as a Charter Member of the LIGO Scientific Collaboration (LSC) and a member of the LIGO Advanced Data Analysis Group (ADAG). The period of performance for the activities in this Attachment is from August 15, 1999 to February 15, 2000. This period may be modified by agreement to a revision of this Attachment.

1. LIGO Scientific Collaboration - The LIGO Scientific Collaboration is organized as a separate organization from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own leadership and governance. The Collaboration will ensure equal scientific opportunity for individual participants and institutions. It will organize the research, publications, and all other scientific activities. The Collaboration will report to the Laboratory Directorate for final approval of its research program, technical work, observational physics publications, and talks announcing new observations and physics results. This will be done through regular reports to the Directorate and its PAC.
2. Charter Membership - An initial period for formation of the Charter group of institutions in the LIGO Scientific Collaboration commenced on March 1, 1997 and ended following the first full meeting of the Collaboration at which the Collaboration Council assumed its role.

Following the charter period proposals will be evaluated through the Collaboration Council. With Collaboration approval, an MOU with the LIGO Laboratory, including Attachments defining specific work, will be required for any participating institutions.

3. This document is an agreement between the Caltech Relativity Group (CaRT) and the LIGO Laboratory concerning the activities of CaRT as a Collaborating Institution in the LIGO Scientific Collaboration (LSC) and in the LIGO Advanced Data Analysis Group (ADAG), and as noted in Item No. 8 below.
4. LIGO Advanced Data Analysis Group - The LIGO Advanced Data Analysis Group (ADAG) is the scientific collaboration for modeling gravitational-wave sources and for computation of associated waveforms that are beyond the LIGO I sensitivity. A specific Attachment will define the roles and responsibilities of LSC groups participating in ADAG group. Members of

ADAG group will normally be authors on publications reporting the work of the group and will normally be eligible to participate in data runs and science beyond the LIGO I data run.

5. Report of Progress - CaRT will provide a status report on its activities in support of LIGO every six months. The report will consist of: a) a summary status on research by topic as indicated Item No.8 below including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time, b) updated List of Collaborators, and c) a plan of activities for the succeeding six-monthly period. The report will be due one month before the close of the period of performance under the Attachment in question.
6. Term of Membership - The Membership will be renewed every six months upon evidence of satisfactory performance of agreed upon duties.

The coordinates of CaRT members are included in the Attachment Z to the Memorandum of Understanding LIGO-M950019-00-M.

7. Intellectual Property Rights - The rights to intellectual property developed under this Attachment will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.
8. During the period August 15, 1999 to February 15, 2000, a significant portion of CaRT's research will deal with the modeling of gravitational-wave sources and computations of waveforms; this work is performed outside the LSC. However, CaRT's studies of the implications of this and other source modeling for LIGO, as indicated below, fall within the LSC purview.

The CaRT leadership will continue to train a new group of graduate students and postdoctoral fellows in the LIGO-related research. The contributions to LIGO will be made by the following people:

Experienced personnel - Kip Thorne, Lee Lindblom (a senior scientist in CaRT), Teviet Creighton (graduate student, will complete Ph.D. and move to Milwaukee in September), Yuri Levin (completed his Ph.D. in May; will be a postdoctoral fellow in CaRT until September, then move to Berkeley).

New personnel as of this past year - Yuk Tung Liu (graduate student), Patricia Purdue (graduate student) and Michelle Vallisneri (graduate student).

New personnel arriving in September - Scott Hughes (postdoctoral fellow) and Alessandra Buonanno (postdoctoral fellow).

The work plan for the period August 15, 1999 to February 15, 2000 is as follows:

- a. L. Lindblom, and possibly Y. Levin, will explore further the consequences for LIGO of gravitational wave emission from superfluid neutron stars in Low Mass X-Ray Binaries.

- b. Y. Liu will continue to explore implications for LIGO of nonaxisymmetric instabilities in accretion-induced collapse of white dwarf stars.
  - c. Y. Levin and K. Thorne will continue an exploration of the use of LIGO to search for narrow-band gravitational waves at 37kHz and its harmonics.
  - d. M. Vallisneri and possibly others will continue to study the implications for LIGO of tidal disruption of neutron stars in neutron star / black-hole binaries.
9. During the period August 15, 1999 to February 15, 2000, the LIGO Laboratory will share as requested and appropriate the LIGO data of relevance to the research topics in Item No. 8 above.
10. The research effort pursuant to this Attachment E will be coordinated by K. Thorne and Albert Lazzarini on behalf of CaRT and LIGO Laboratory respectively.
11. Resource Sharing: The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities and funding in support of the effort in Item No. 8, as indicated below. These resources will be in addition to the coordination effort and data to be made available per Item No. 9 above.
- a) Provide accommodations for investigators from other institutions in Item No. 8 above while on research assignment on LIGO at Caltech.
  - b) Contribute funding for MSURG's collaboration in support of LIGO. Funding is provided under a subcontract between the Caltech and US Civilian Research and Development Foundation (USRDF). The funding authority is National Science Foundation (NSF) Grant No. 9800097.

Approved:

Barry Barish  
Barry Barish  
LIGO Laboratory Director

12-27-99  
Date

Kip S. Thorne  
Kip S. Thorne  
CaRT Principal Investigator

1-6-00  
Date