

Memorandum of Understanding (LIGO-M050370-00-M)

between the

Columbia Experimental Gravity Group (GEC0)

and the

Laser Interferometer Gravitational Wave Observatory (LIGO)

August 15, 2005

The purpose of this Memorandum of Understanding (MOU) is to establish and define a collaborative relationship between the Columbia Experimental Gravity Group (GEC0) and the Laser Interferometer Gravitational-Wave Observatory (LIGO). Both parties to this agreement share the broad goals of developing the instruments and techniques for detecting and studying gravitational waves, and subsequently using them as an astrophysical probe. Under this MOU, the GEC0 Group will be a member group of the LIGO Scientific Collaboration.

1. The Columbia Experimental Gravity Group (GEC0) consists of Professor Szabolcs Márka and typically one research scientist, two graduate students and two to six undergraduate students. The group will focus on astrophysical trigger based data analysis, and diagnostic, calibration, commissioning and development projects aimed towards enhancing the astrophysical reach of the LIGO detectors.
2. LIGO comprises two parts: the LIGO Laboratory and the LIGO Scientific Collaboration. These two entities report to the LIGO Directorate, consisting of the LIGO Director, the LIGO Scientific Collaboration Spokesperson, and the LIGO Laboratory Deputy Director. The design and construction of the LIGO Observatories were carried out by California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT) under a Cooperative Agreement between the National Science Foundation (NSF) and Caltech. The LIGO Oversight Committee supervises the realization of LIGO.
 - A. The LIGO Laboratory is responsible for the operation of the LIGO Observatories, the development and implementation of future detector systems, and participates in all aspects of the research with the LIGO detectors. LIGO is a system of three interferometric Fabry-Perot antennas, two of them 4 kilometers long and the third one 2 kilometers long, aimed at the simultaneous detection of gravitational waves in the frequency range 40-6000 Hz. LIGO Observatories are located in Hanford, Washington and in Livingston Parish, Louisiana (USA) and began observations in the year

2002. The LIGO Laboratory is funded through a Cooperative Agreement between the National Science Foundation and Caltech, with the portion of the LIGO Laboratory at MIT funded through a subcontract from Caltech.

- B. The LIGO Scientific Collaboration (LSC) is organized as a separate entity from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own governance and leadership (which includes the LSC Spokesperson as a member of the LIGO Directorate). The Collaboration ensures equal scientific opportunity for individual participants and institutions. It organizes the research, publications, and all other scientific activities. The Collaboration reports to the LIGO 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 Program Advisory Committee. The organization of the LSC and its governance are defined in its Charter.
3. As a member group of the LSC, the GECo Group will participate in the governance of the LSC and in setting its policies and procedures, as defined in the LSC charter. Similarly, it agrees to abide by the policies and procedures adopted by the LSC and posted on its website (<http://www.ligo.org/policies.html>), concerning publication, data access, software standards, and so on.
 4. Membership in more than one collaboration active in the same area of research may present complications. Members of the LSC contemplating joining other gravitational wave collaborations or participating in data analysis efforts with collaborations outside a framework established by the LSC should inform and consult with LSC and the LIGO Laboratory to ensure that no conflicts of interest exist.
 5. The LSC is the primary advocate of interferometric gravitational wave research in the U.S. To function effectively in this role, it needs to be informed in advance about major new initiatives. The GECo Group agrees to inform the LSC of any major new proposals related to LIGO to be submitted to the NSF, and to consult with the LSC concerning the best approach to support the overall LIGO program. The final decision about the scope of any such proposal shall remain the prerogative of the GECo Group.
 6. LSC Service Functions - Participation in the LSC brings with it responsibility for service functions to support the overall effort in achieving high detector sensitivity and high data quality. In particular, each LSC group is expected to assist in the staffing of scientific monitoring shifts during organized data runs. The staffing of these shifts is notable for both its importance and the travel burden it places on scientists. This burden makes an equitable shift allocation mechanism necessary.

A nominal guideline is that each LSC group should staff a fraction of the shifts comparable to its FTE fraction devoted to LSC activities. Szabolcs Márka (GECo

Group) will be responsible for interaction with the designated LSC Shift Organizer with respect to the GEC0 Group's Service Function commitments.

Groups making extensive contributions to the LSC in other service efforts that involve a substantial travel burden may request a reduction in their nominal share of shift staffing. Those efforts can include:

- Commissioning and instrument improvement
 - Participation in on-site detector characterization investigations
 - Development/operation of analysis software/hardware infrastructure and validation of analysis software that requires travel away from the home institution.
7. 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 institution.
 8. Attachments to this MOU will be prepared annually to define the specific activities and responsibilities of the GEC0 Group and to define any resources to be provided by the LIGO Laboratory to the GEC0 Group in support of those activities.
 9. GEC0 Group will provide an annual status report on its activities in support of LIGO. The report will consist of a summary status on research by topic as indicated in the Attachments for that period 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 by each member of the group. The report will be due one month before the close of the period of performance under the Attachments in question.
 10. The LSC will review the progress report against the Attachments from the previous year and assess the Attachments for the up-coming year annually, under its established procedure, and recommend acceptance or rejection of each Attachment by the LIGO Director and the LSC Spokesperson.
 11. A list of GEC0 Group members will be updated at least every six months. GEC0 Group members and appropriate contact information will be provided in electronic form as Attachment Z to this Memorandum of Understanding. In cases where individuals who leave the group have had access to LIGO data and this access should be terminated, the GEC0 Group Principal Investigator is responsible for timely notification to the Directorate and to the computing committee so access may be revoked.
 12. The LIGO Laboratory is responsible for obtaining NSF approval of collaborative Memoranda of Understanding where required. All Memoranda of Understanding will be provided to NSF for their information.
 13. The rights to intellectual property developed under this Attachment using LIGO

Laboratory resources will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.

- A. In the event a patentable invention is conceived or first actually reduced to practice during the work of a member(s) of the GECo Group at LIGO Laboratory facilities, he/she will:
 - i) make prompt disclosure of the invention to the Director of the LIGO Laboratory; and
 - ii) cooperate with LIGO Laboratory and supply all information and execute all papers including invention reports, records of invention, patent applications and powers of attorney, necessary and proper to fulfill the obligations of the LIGO Laboratory to the U.S. Government sponsor.
- B. The ownership of inventions conceived solely by members of the GECo Group at LIGO facilities shall be owned by the Columbia University, although the LIGO Laboratory shall be granted a license to use such invention for noncommercial research purposes at LIGO facilities. Inventions that are conceived by both members of the GECo Group and LIGO Laboratory staff as part of the LIGO project shall be jointly owned and any income from commercial licensing shall be shared in proportion to the number of joint inventors from each institution.

In all other regards, the rights to intellectual property developed by members of the GECo Group under this Attachment will be in accordance with the policies of Columbia University.

- 14. This MOU supersedes the previous MOU between the LIGO Laboratory and the GECo group (LIGO-M040224) and its amendments and attachments. This MOU will remain in force until the parties mutually agree to terminate it, or until it is terminated in accordance with LSC procedures.

Approved:

Barry Barish
LIGO Director

Szabolcs Márka
Principal Investigator
Columbia Experimental Gravity Group (GECo)

Peter Saulson
LSC Spokesperson

Attachment DAT to the
Memorandum of Understanding (LIGO-M050370-00-M)
between the
Columbia Experimental Gravity Group (GEC0)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment DAT to the Memorandum of Understanding LIGO-M050370-00-M defines the role of the Columbia Experimental Gravity Group (GEC0) as a Member of the LIGO Scientific Collaboration (LSC), in particular, its activities in data analysis in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Together, the LIGO Laboratory and the LIGO Scientific Collaboration are responsible for implementing and exploiting the initial LIGO detector through its science data runs. The LSC has organized the data analysis effort into search groups which coordinate the analyses, perform detailed reviews, and prepare publications on behalf of the collaboration. LSC groups are encouraged to participate in one or more of these groups. MOU Attachments define the contributions of each participating group to the data analysis groups.
2. During the period August 15, 2005 to August 15, 2006, the members of GEC0 Group will participate in the analysis of initial LIGO data in the following areas:

Astrophysical trigger based analysis:

- Coordination of the work of the Extrig group
 - Triggered, prompt analysis (starts ~<45 minutes after the trigger) takes less than 12 hours to get the preliminary results and nominally 24-36 hours to have an executive summary (depending on human schedule)
 - Search for short duration GW signatures of GRBs during S5
 - Search for long duration GW signatures of GRBs based on models by Maurice van Putten and Rafael Araya-Gochez during S5
 - Complete the analysis of SGR-1806 using the available AstroWatch data
3. 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. 2, as indicated below.
 - a) Research accommodations for GEC0 group members while on LIGO research assignment at any LIGO Laboratory site,
 - b) Access to LIGO data through established LSC channels in support of this work.

4. Coordination and Reporting – GEC0 Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2) will be carried out within the LSC Burst Search Group. Coordination will include keeping the Group leaders informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.

In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, 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. This Attachment will be updated at least annually with a plan of activities for the succeeding on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Approved:

Barry Barish
LIGO Laboratory Director

Szabolcs Márka
GEC0 Principal Investigator

Peter Saulson
LSC Spokesperson

Erik Katsavounidis
LSC Burst Search Group Leader

Albert Lazzarini
LIGO Laboratory Data and Computing
Group Leader

**Attachment OPS to the
Memorandum of Understanding (LIGO-M050370-00-M)
between the
Columbia Experimental Gravity Group (GEC0)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005**

This Attachment OPS to the Memorandum of Understanding LIGO-M050370-00-M defines the role of the Columbia Experimental Gravity Group (GEC0) as a Member of the LIGO Scientific Collaboration (LSC) in the areas of detector commissioning, detector characterization, and operations in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Together, the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) are responsible for implementing and exploiting the initial LIGO detector through its science data runs. LSC groups are encouraged to contribute to the commissioning, characterization, and operation of the LIGO detectors, as members of working groups established by the LIGO Laboratory and the LSC.
2. During the period August 15, 2005 to August 15, 2006, the members of GEC0 Group will participate in the initial LIGO detector research program in the following areas:
 - a) *Commissioning effort:*
 - Commissioning and testing support for the S5 timing upgrade
 - Contribution in the detector stability and sensitivity improvements.
 - Participation in calibration studies
 - b) *Diagnostic and detector characterization projects:*
 - Timing studies, including monitoring software/hardware improvement/maintenance
 - Spectrum consistency/stationarity studies, including monitoring software improvement/maintenance
 - DMT infrastructure development and maintenance: (SPI and WebView)
 - Implement needed new ideas (dependent of available manpower and LIGO lab priorities)
 - c) *LIGO Operation:*
 - Participate in scientific shifts during science runs
 - Work with operators to make the control room tools developed by GEC0 members more and more useful
 - Listen and act on the ideas/request of operators to develop new tools (dependent of available manpower and LIGO lab priorities)

3. 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. 2, as indicated below.
 - a) Research accommodations for GEC0 group members while on LIGO research assignment at any LIGO Laboratory site,
 - b) Access to LIGO data through established LSC channels in support of this work.
4. Coordination and Reporting – GEC0 Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2a) will be carried out in coordination with the LIGO Laboratory Commissioning Leader, Item 2b) will be carried out within the Detector Characterization Working Group of the LSC, and Item 2c) will be carried out in coordination with the LHO {or LLO} Site Head. Coordination will include keeping the Group leaders informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.

In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, 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. This Attachment will be updated at least annually with a plan of activities for the succeeding on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Approved:

Barry Barish
LIGO Laboratory Director

Szabolcs Márka
GEC0 Principal Investigator

Peter Saulson
LSC Spokesperson

Keith Riles
LSC Detector Characterization Leader

Peter Fritschel
LIGO Lab Commissioning Leader

**Attachment Number Z to the
Memorandum of Understanding (LIGO-M050370-00-M)
between the
Columbia Experimental Gravity Group (GEC0)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory**

This Attachment to the Memorandum of Understanding LIGO-M050370-00-M lists the coordinates of members of the Columbia Experimental Gravity Group (GEC0) who will participate in the LIGO Scientific Collaboration (LSC) as members of LIGO Development Groups. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006. This period may be modified by agreement to a revision of this Attachment. This list may be extended by agreement to a revision of this Attachment.

Name	Address	E-Mail/Web	Phone Nos.	Begin Date	End Date
Márka, Szabolcs RFTE 80% LIGO I 95 % AdvLIGO 5% Faculty	Columbia University, Columbia Astrophysics Laboratory, Department of Physics, 550 West 120th Street, Mail Code 5247, New York, NY 10027	smarka@ phys.columbia.edu	Tel: 212-854-8209 Fax: 212-854-3379	Aug. 15, 2005	Aug. 15, 2006
Matone, Luca RFTE 100% LIGO I 70% AdvLIGO 30% Research Scientist	Columbia University, Columbia Astrophysics Laboratory, Department of Physics, 550 West 120th Street, Mail Code 5247, New York, NY 10027	matone@astro.colu mbia.edu	Tel: 212-854-6429 Fax: 212-854-3379	Aug. 15, 2005	Aug. 15, 2006

Rollins, Jameson RFTE 100% LIGO I 95% AdvLIGO 5% Graduate Student Taking classes	Columbia University, Columbia Astrophysics Laboratory, Department of Physics, 550 West 120th Street, Mail Code 5247, New York, NY 10027	jrollins@phys.columbia.edu	Tel: 212-854-5762 Fax: 212-854-3379	Aug. 15, 2005	Aug. 15, 2006
Kalmus, Peter RFTE 100% LIGO I 95% AdvLIGO 5% Graduate Student Taking classes	Columbia University, Columbia Astrophysics Laboratory, Department of Physics, 550 West 120th Street, Mail Code 5247, New York, NY 10027	peter@phys.columbia.edu	Tel: 212-854-5762 Fax: 212-854-3379	Aug. 15, 2005	Aug. 15, 2006

Scientific Collaboration Council Delegate: Szabolcs Márka

Preceding year's attachment Z contained only Márka, his coordinates remained the same.

Authorship: Based on their past contribution, present performance, allocated FTE fraction and strong commitment towards the future of LIGO, the following group members should appear on the author list of the papers (in alphabetical order):

- Peter Kalmus
- Luca Matone
- Szabolcs Márka
- Jamieson Rollins

Approved:

Barry Barish
LIGO Laboratory Director

Szabolcs Márka
Principal Investigator
Columbia Experimental Gravity Group (GECG)

Peter Saulson
LSC Spokesperson