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Editorial
The next newsletter is due December 2017. This and all subsequent issues will be available on the web at https://files.oakland.edu/users/garfinkl/web/mog/ All issues before number 28 are available at http://www.phys.lsu.edu/mog

Any ideas for topics that should be covered by the newsletter should be emailed to me, or Greg Comer, or the relevant correspondent. Any comments/questions/complaints about the newsletter should be emailed to me.

A hard copy of the newsletter is distributed free of charge to the members of the APS Division of Gravitational Physics upon request (the default distribution form is via the web) to the secretary of the Division. It is considered a lack of etiquette to ask me to mail you hard copies of the newsletter unless you have exhausted all your resources to get your copy otherwise.

David Garfinkle

Correspondents of Matters of Gravity
• Daniel Holz: Relativistic Astrophysics,
• Bei-Lok Hu: Quantum Cosmology and Related Topics
• Veronika Hubeny: String Theory
• Pedro Marronetti: News from NSF
• Luis Lehner: Numerical Relativity
• Jim Isenberg: Mathematical Relativity
• Katherine Freese: Cosmology
• Lee Smolin: Quantum Gravity
• Cliff Will: Confrontation of Theory with Experiment
• Peter Bender: Space Experiments
• Jens Gundlach: Laboratory Experiments
• Warren Johnson: Resonant Mass Gravitational Wave Detectors
• David Shoemaker: LIGO
• Stan Whitcomb: Gravitational Wave detection
• Peter Saulson and Jorge Pullin: former editors, correspondents at large.
Division of Gravitational Physics (DGRAV) Authorities

Chair: Peter Shawhan; Chair-Elect: Emanuele Berti; Vice-Chair: Gary Horowitz.
Secretary-Treasurer: Geoffrey Lovelace; Past Chair: Laura Cadonati;
Councillor: Beverly Berger. Members-at-large: Duncan Brown, Michele Vallisneri,
Kelly Holley-Bockelmann, Leo Stein, Lisa Barsotti, Theodore Jacobson.
Student Members: Megan Jones, Cody Messick.

DGRAV News
we hear that …

David Garfinkle, Oakland University, garfinkl@oakland.edu

• Rainer Weiss, Kip Thorne, Barry Barish and the LIGO Scientific Collaboration have been awarded the 2017 Princess of Asturias Award for Technical and Scientific Research.
• The LIGO team has been awarded the 2017 Group Achievement Award of The Royal Astronomical Society.
• Gabriela González and the LIGO Scientific Collaboration have been awarded the Bruno Rossi prize of the High Energy Astrophysics Division of the American Astronomical Society.
• Barry Barish and Stan Whitcomb have been awarded the Henry Draper Medal of The National Academy of Sciences.
• David Reitze, Gabriela González, and Peter Saulson have been awarded The National Academy of Sciences Award for Scientific Discovery.
• Gabriela González has been elected to The National Academy of Sciences and to The American Academy of Arts and Sciences.
• Nergis Mavalvala has been elected to The National Academy of Sciences and to The American Academy of Arts and Sciences.
• Gabriela González has been named by the journal Nature to their 2016 list of Ten people who mattered this year.
• David Shoemaker has been elected Spokesperson of the LIGO Scientific Collaboration.

Hearty Congratulations!

DGRAV student travel grants
Beverly Berger, LIGO, beverlyberger@me.com

SUPPORT DGRAV STUDENT TRAVEL GRANTS The American Physical Society's Division of Gravitational Physics (DGRAV) has launched a campaign to endow the DGRAV Student Travel Grants. We invite you to help us ensure its success! First awarded in 1999 by DGRAV’s predecessor, the Topical Group in Gravitation, these grants provide partial travel support to allow DGRAV student members to present their work at the APS April Meeting. They not only benefit the students, but also provide other participants the opportunity to meet the grant recipients and learn about their work.

Over the past few years, support for student travel has become one of DGRAV’s core missions and, accordingly, consumes a major fraction of the DGRAV budget. As the field, the number of students in the field, and the significance of the APS April Meeting to the field have increased, so have the applications for travel grants.

For example, the number of applicants jumped from 22 in 2014 to 45 in 2015—the General Relativity Centennial. While the 2016 number was “only” 28, this level of demand is still unsustainable. As a consequence, DGRAV can no longer support all the high quality applications we receive. Therefore, the purpose of this endowment is to provide funding for this activity at a level beyond that achievable now by DGRAV. Our campaign goal is to raise $75,000, enough to support 10 students every year alongside those funded from the DGRAV operating budget. We hope that future growth in the endowment will match growth in the demand. At the time of writing (6/17/2017) we have raised $46,250 towards our goal. We need your help to get all the way there.

More information is available at https://www.aps.org/about/support/campaigns/dgrav/index.cfm including instructions on how to donate. Donors will be recognized on the campaign website, in the DGRAV newsletter Matters of Gravity, as well as on the DGRAV website (unless you prefer that your gift not be recognized publicly).

Contact information:
Beverly K. Berger, Chair, DGRAV Student Travel Grants Endowment Campaign, beverlyberger@me.com
Irene Lukoff, APS Director of Development, lukoff@aps.org
Tora Buttaro, APS Donor Relations Program Manager, buttaro@aps.org

The Discovery of GW170104

Jenne Driggers, LIGO Hanford Observatory, jenne.driggres@ligo.org
Salvatore Vitale, MIT, salvatore.vitale@ligo.mit.edu

LIGO has detected gravitational waves for the third time (or fourth, if you believe that LVT151012 is of astrophysical origin), on January 4, 2017.

The source, a binary black hole coalescence dubbed GW170104, was discovered with the two NSF-funded Advanced LIGO detectors just over a month after the beginning of the second observing run, which started on November 30, 2016. The LIGO Scientific Collaboration, with the Virgo Collaboration, publicly announced the findings on June 1, 2017.

A year-long break between the first and second observing runs was spent implementing a series of upgrades at both sites. The Hanford observatory focused on increasing the laser power circulating in the interferometer. While we are able to operate at double the first run’s input power, noise performance challenges encouraged us to back down to only 50% more input power. This work was still a success in that we have developed infrastructure to damp unstable opto-mechanical modes which can cause the interferometers to fall out of resonance, and diagnosed many other technical issues that will become important when we do go to higher power after this run. The Hanford site also made great strides in increasing robustness against various environmental conditions, particularly times of high wind. Ground tilt sensors now measure how much the floor below the interferometer tilts, and once we take that into account we are able to achieve roughly 80% duty cycle, including one continuous data stretch over 71 hours long. At the same time, the Livingston observatory found some sources of scattered light inside the vacuum system, and were able to improve their low frequency sensitivity between 50 Hz and 200 Hz.

The hard work paid off shortly after the detectors came back
online, with the discovery of GW170104.

But not everything went exactly as planned. Under normal circumstances, low-latency algorithms searching for compact binaries in LIGO data would alert the observatories and data analysts when a significant trigger is found in both data streams. However, at the time of the event, the Hanford site suffered a problem with the subsystem that reports on the status of the calibration. The signal was thus first identified by manually inspecting low-latency triggers in the Livingston data only. Shortly after, it was verified that the calibration at both sites was in a nominal state, and the data from Hanford included in the analysis.

It was worth the struggle, since very soon it became clear that GW170104 was every bit as interesting as the two clear detections made in the first observing run.

A preliminary map with the source localization was released to partner astronomers, and followed up by over 30 facilities for potential electromagnetic or neutrino counterparts. At the time this newsletter is written, no significant counterparts have been claimed.

With a false alarm ratio smaller than 1 in 70,000 years of coincident data, and a probability of being of astrophysical origin which differs from 1 by $3 \times 10^{-5}$, GW170104 stands clearly above the instrumental background.

Among the many reasons why LIGO's first discovery, GW150914, was extraordinary is that it showed that stellar mass black holes can have large masses. Stellar mass black holes found in X-ray binaries all have masses smaller than 15 solar masses. The component black holes of GW150914 were a factor of two heavier, suggesting their progenitor stars formed in a low metallicity environment. The second confident event, GW151226, was made of smaller black holes, of masses compatible with what is found in X-ray binaries. GW170104 is in the middle, with a primary object at 31 solar masses and secondary at 19 solar masses.

LIGO is thus accessing a population of black holes covering a large range of masses. Assuming that the mass function of black holes in binaries follows a power law, we can measure its slope $\alpha$. Using the 4 detections we have thus far, we have obtained $\alpha = 2.3^{+1.3}_{-1.4}$. The median of our measurement is remarkably close to the exponent of the Salpeter mass function. More detections will allow us to further improve this measurement.

The detection of GW170104 has allowed us to slightly tighten our measurement of the merger rate for binary black holes. The discoveries of the first observing run had led to an estimate of $9 - 240$ Gpc$^{-3}$ yr$^{-1}$. Including GW170104, we obtain $12 - 213$ Gpc$^{-3}$ yr$^{-1}$. This confirms that black hole mergers are common in the universe, and will be detected in large numbers in the future.

One of the unsolved problems about compact binaries such as those detected by LIGO is how and where they formed. Two scenarios are typically considered: isolated binary evolution and dynamical formation. In the first case the formation happens in galactic fields, via a common envelope evolution or other mechanisms. In the second case, the two black holes dynamically form a bound system in a dense environment such as a globular cluster, or near a galactic nucleus. Whether both channels happen, and with which relative frequency, is an open question in astrophysics.

Black hole spins are one of the keys to answer these questions. Whereas dynamical formation quite naturally results in random spin orientations, isolated binary evolution typically predicts binaries with only moderate spin misalignment with respect to the orbital angular momentum. This implies that the mass-weighted projection of the total spin along the orbital angular momentum, also known as effective spin, can have both signs for systems evolved dynamically, while it should be positive for isolated binaries.

For GW150914 the posterior of the effective spin was centered at zero, whereas for GW151226 it preferred positive values, which is compatible with both formation channels. The situation is different for GW170104, for which roughly 80% of the posterior probability is for negative effective spin. While positive values are not excluded, there seems to be a preference for a dynamical formation. The evidence is not conclusive, but it shows what kind of information is accessible with gravitational waves. As more sources are detected, we will be able to further study the formation channels of compact binaries.

LIGO's detections give us access to regions of the space-time where the gravitational field is strong and dynamical. As such, they are the ideal tool to stress test general relativity. Over the last several decades, a large number of alternative theories of gravity have been proposed. In some of them, one of the fundamental laws of physics, Lorentz invariance, is broken, which affects the dispersion relation for gravitational waves. In these theories, gravitational waves do not travel at the speed of light but rather have a frequency-dependent group velocity.

We have used GW170104, as well as the events detected in the first observing run, to put upper limits on the magnitude of Lorentz violation tolerated by our data. The bounds we obtain are weaker than those existing from electromagnetic or neutrino observations. However, they are still important! In fact, there are theories in which Lorentz invariance is only broken in the gravity sector, leaving the neutrino and electromagnetic sectors unaffected. Ours are the first constraints based on gravitational waves, and the first tests of superluminal propagation in the gravitational sector.

We have also considered a modification of general relativity in which gravitons are dispersed in vacuum like massive particles. This way, we obtained an upper bound for the graviton mass at $7.7 \times 10^{-23}$ eV/c$^2$, improving the results of the first observing run. Finally, we performed unmodeled tests. First, we augmented the waveform model with extra phase coefficients not normally present in general relativity, and we measured them. For all these extra parameters, the posterior distributions contain zero, which is the general relativity value. Next, we verified that the early portion of the detected signal yield mass and spin estimates which are consistent with what can be measured from the final portion of the waveform. In this case too general relativity is sufficient to describe GW170104. While we are thrilled that Einstein's gravity has brought us so far, allowing us to successfully detect and characterize GW170104 and the previous sources, we will keep testing.

The second observing run will last for another few months, probably until the end of the summer. It will not be business as usual, though. The Virgo interferometer in Italy has successfully locked and is collecting data, although still at a low sensitivity. As Virgo improves, a short joint observing run could happen by the end of the summer. A third detector could significantly reduce the uncertainty in the sky position of the sources, increasing the chances of successfully detecting an eventual electromagnetic counterpart to gravitational-wave detections. Work has already begun in the LVC to be sure everything is in
place for when Virgo data will be used for joint analysis.

Once the second observing run is complete, both observatories will again go offline, likely for more than one year, for a large set of upgrades and some vacuum facilities maintenance. Many of these upgrades to the interferometers are based on lessons learned over the past two years. The lasers at both sites will be replaced which will allow us to inject more laser power into the interferometer with less beam motion jitter than our current high power lasers. The Livingston observatory, and perhaps also Hanford, will inject squeezed quantum states of light into the interferometers. The goal is to have 3 dB of effective squeezing, which is equivalent to again doubling the input laser power, but without the challenges of the thermal input of higher power. Some of our other upgrades include installing baffles to catch many more stray light beams, and prevent them from potentially scattering back into the main laser beam path. The so-called reaction masses that sit about 5 mm behind the highly reflective end mirrors will be replaced with annular versions rather than the current disc geometry. This will allow us to continue using them as a quiet actuation reference for the test mass mirrors without suffering from thin film gas damping due to molecules bouncing between the surfaces of the mirror and the reaction mass, and potentially reducing the effect of electromagnetic charge on our calibration. Our readiness to begin our third observing run will be driven by achieving a significant increase in sensitivity over the current run.

While 2015 has been the year of the discovery, 2017 is truly the year of the beginning of gravitational-wave astronomy. Already after three confident detections we have significantly broadened our understanding of black holes, including their masses and spins. We have put general relativity under scrutiny, and found it consistent with the detected signals.

As more and different types of sources are discovered, information from gravitational waves have the potential to dramatically change what we know about compact objects, matter, and gravity.

Fasten your seatbelts.

**Remembering Vishu**

**Naresh Dadhich**, ICUAA, [nnkd@iucaa.in](mailto:nnkd@iucaa.in)
**Bala Iyer**, Tata Institute of Fundamental Research, [bala.iyer@icts.res.in](mailto:bala.iyer@icts.res.in)

C V Vishveshwara, or Vishu, is associated in the minds of most of us with quasi-normal modes or the ringdown of a black hole. The prediction that his simple calculations made was dramatically verified after 46 years with the discovery of gravitational waves by LIGO. It was almost a year before he breathed his last on 16 Jan 2017 in Bengaluru. It was, therefore, most fortuitous that he could experience exhilaration almost a year before he breathed his last on 16 Jan 2017 in Bengaluru. It was, therefore, most fortuitous that he could experience exhilaration almost a year before he breathed his last on 16 Jan 2017 in Bengaluru. It was, therefore, most fortuitous that he could experience exhilaration almost a year before he breathed his last on 16 Jan 2017 in Bengaluru. It was, therefore, most fortuitous that he could experience exhilaration almost a year before he breathed his last on 16 Jan 2017 in Bengaluru. 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consequent existence of the ergosphere [1]. Regarding this work Jacob Bekenstein commented [2]: “I was familiar with the Vishu theorem that the infinite redshift surface of a static black hole is always the horizon. At that time black hole physics was just getting started and such neat relations between black hole features were rare. Vishu’s theorem was a welcome hard fact in the middle of such folklore and helped clarify in mind what black holes were about. At the conference (GR6) I had a long talk with him and I vividly remember being impressed by the range of research problems he had going simultaneously.”

Vishu was the first to prove the stability of non-rotating black holes under linear perturbations [3]. Regarding this Brandon Carter remarked [2]: “Vishu was one of the first to appreciate the importance of this problem and who played an important role in persuading others to take the problem seriously as something of potential astrophysical relevance by providing the first convincing proof that at least in one case namely the Schwarzschild solution, such an equilibrium state can be stable.” Elaborating further Bernard Whiting wrote [2]: “Visheshwara’s original discussion of stability showed that there was no superficial case establishing the instability basically by dealing with single modes and by demonstrating the positivity of effective potentials. Establishing pointwise boundedness requires use of more refined tools leading to a method that differs markedly in substance but not at all in essence from the relatively simple positive potential approach. Vishu made a number of significant breakthroughs...”

Vishu was the pioneer who explored how black holes respond when externally perturbed [4] and proved that regardless of the perturbation, Schwarzschild black holes get rid of any deformation imparted to them by radiating gravitational waves with a frequency and decay time that depended only on their mass. These characteristic waves are technically termed quasi-normal modes, which is why after the announcement of the gravitational wave detection by LIGO Vishu laid the claim to the nom de plume Quasimodo of black holes. Quasi-normal modes are like the dying tones of a bell struck with a hammer and are referred to as the ringdown radiation. Vishu’s work is fundamental to our understanding of black holes and began a new chapter in how to study them.

Many of us met Vishu during the Einstein Centenary symposium at Physical Research Laboratory, Ahmedabad in 1979. Though we have other wonderful memories of the symposium the most memorable one was Vishu’s lecture entitled ‘Black Holes for Bedtime’. It was a magical experience; an exotic cocktail of science, art, humor and caricature. Equations were not necessarily abstract and unspeakable and could well be translated in the best literary tradition if you were Vishu!

At Raman Research Institute and later Indian Institute of Astrophysics Vishu explored problems in classical general relativity with possible astrophysical implications. Perturbations of black holes in general relativity carry signatures of the effective potential around them and one could look for them by examining neutrinos in gravitational collapse or ultracompact objects. Could one discern possible differences between black hole solutions in general relativity and other theories of gravity by looking at their quasi-normal modes and the properties of their horizons? How different are black hole solutions in cosmological backgrounds from those in the usual asymptotically flat ones? How does one use the Frenet-Serret formalism to study gyroscopic precession, general relativity analogs of inertial forces, and characterize black holes in higher dimensions in a covariant and geometric manner? Other mathematical issues studied related to separability of different spin perturbations in general relativity, the role of the Killing tensor in separability of wave equations among others. It was always a pleasure working with Vishu. There was no pressure, no generation gap, a natural possibility to grow and contribute your best, an easy personal rapport, a refreshing sense of humor, an unassuming erudition and most importantly a warm and wonderful human being.

Together with J.V. Narlikar, Vishu played a key role in bringing long due recognition to the doyens of general relativity P.C. Vaidya and A.K. Raychaudhuri. A volume entitled Random walk in relativity and cosmology co-edited by them was released in 1986 at RRI and its royalties supplemented by royalties of the International Conference on Gravitation and Cosmology (ICGC) proceedings were used to set up the Vaidya-Raychaudhuri endowment lecture of the Indian Association for General Relativity and Gravitation (IAGRG). Vishu was closely involved in the group that initiated, planned and organized UGC Schools on general relativity and cosmology in the 1980s. The motivation was to extend Indian research in exact solutions in general relativity to modern research frontiers in cosmology, early universe and relativistic astrophysics. This led to the ICGC meetings organized every four years because it was recognized that due to limited resources, participation of the Indian researchers in the International Society of General Relativity and Gravitation (ISGRC) meetings was very limited. Creating an opportunity for the IAGRG community to interact with international experts on front line research areas in relativity and cosmology in India was needed to assist in improving the quality and relevance of general relativity research in India. These meetings also brought out the cartoonist in Vishu during the first ICGC in Goa. Between sessions cartoons would appear on the screen anonymously and by the end of the meeting there were multiple reprint requests for them! Staid Cambridge University Press was happy to include them in the proceedings and Vishu’s cartoons in the ICGC proceedings were a treat to look forward to. The series of cartoons on gravitational waves in those proceedings deserves special mention. Alas they are incomplete since he could not make one after the discovery. Just on the day he passed away Nils Andersson wrote Vishu an email: “I have recently done something that I think might amuse you. I have written a little book involving Einstein, relativity and a fair bit of fictional freedom. Now, I think it is fair to say that my attitude to this project has been heavily inspired by your story-telling, your drawings and the bathtub book [5].”

Vishu’s public lectures inspired a number of students all over the country. His lectures at Bangalore Science Forum, started by his Guru Dr H. Narsimiah, always drew huge numbers. He was a best-seller. And, he never disappointed the audience. Without diluting the profound ideas that he would discuss, he would lace the talks with subtle humor that came seamlessly. At Vishu’s passing, countless echoed Sathyaaparkash who exclaimed “This is devastating. I have lost a teacher, a mentor and a friend. More than anything else we are going to miss his ‘serious’ sense of humor in all walks of life, especially science.”

Together with a committed group that included Sanjay Biswas, Vishu was involved in bringing out Bulletin Of Sciences from 1983-1993 to set up a forum to seriously address the social impact of science and technology. To find the means of sustaining it financially he co-edited with Sanjay Biswas and D.C.V. Mallik an interesting volume called Cosmic Perspectives that was dedicated to the memory of M. Vainu Bappu. Together with A. Ratnakar Vishu was instrumental in setting up the RRI Film Club in the 1980s to get access to movie classics from National Film Archives in Pune and from the consulates like the German and French ones.

Jawaharlal Nehru Planetarium (JNP), Bangalore is a wonderful testament to Vishu’s vision which showcases his multi-faceted personality in science communication and education. Starting as its founder director in 1988, Vishu brought together a dedicated and talented team
and inspired them to build a world class planetarium scripting unique shows integrating the best in science and astronomy with the best in world and Indian history, art, literature and music. By example he set up high standards for all the JNP personnel and mentored them till the very end. But JNP was not to be just a theatre. It had to play a role in science education in the city. Thus in 1992 Bangalore Association for Science Education (BASE) was set up by Vishu to systematically expose, attract and mentor students from elementary school, high school and colleges for a career in science. It may surprise many that in spite of being a pure theorist, Vishu firmly believed in doing science experiments. Via activities like ‘Science in Action’ he emphasized the importance of bringing out in young students the joy of seeing scientific phenomena. That was a way to attract them to science. In fact this philosophy of ‘doing’ science underlined every activity that was visualized at JNP in the coming years. SEED (Science Education in Early Development) for middle school children, SOW (Science Over the Weekends) for high school children and at the pinnacle of the educational programs, REAP (Research Education Advancement Programme) for undergraduate students. SEED, SOW and REAP, all have a very strong presence of experiments that make the programs dynamic and vibrant and endearing to students. During the last twenty years, all these programs have seen a steady growth in number of students attending them and also in attracting quality students with a potential to excel in a career in science. No wonder that more than hundred students who passed through JNP are either pursuing PhD programs or have completed them. Some of them are facutly at institutions such as ICTS, JNCASR and IMSc. Finally, setting up of a science park at JNP was also his initiative. In the original plan drawn up in 1997, an ‘Antigravity Cottage’ that mimics the famous ‘Mystery Spot’ in the US and some other places had been envisaged. It was realized in 2016.

When the gravitational wave discovery by LIGO was announced last year, Vishu was elated. We have never seen him so high, thrilled by the possibility that soon there would be events where the quasi-normal modes would be even more strong. The profundness of this discovery is in the realization that the black hole, which is purely a geometric object without any hard surface boundary rings under perturbations like a material object. It is indeed the most telling and ‘visible’ defining property of a black hole. And Vishu was its discoverer. By all accounts, it is a discovery that will endure in relativity textbooks. By that benchmark, there are only a few other contributions from India like the Raychaudhuri equation and Vaidya’s radiating star that will make the grade. On the other hand this discovery sits alongside the celebrated result that a black hole has no hair the ‘No Hair’ theorem. Most important of all, it is one of the few predictions that have been brilliantly verified by the observation of gravitational waves produced by the merger of two black holes. The observed profile has very uncanny resemblance with what Vishu had plotted long ago back in 1970. There are very few predictions which are actually verified by experiment and observation. Vishu’s black hole ringdown is one among those few. This is the true and ultimate measure of a seminal insight.

We will miss you Vishu even as we try very hard to follow your favorite lines from Machado: “Traveler there is no Path, Paths are made by Walking.”

Vishu is survived by his wife Saraswati and two daughters Smitha and Namitha.


**Remembering Cecile DeWitt-Morette**

**Yvonne Choquet-Bruhat,** IHES Paris ycb@ihes.fr

(Editor’s note: Cecile DeWitt-Morette passed away on May 8, 2017. Below is a translation of some remarks given by Yvonne Choquet-Bruhat during the ceremony held at IHES in which Cecile was elevated to the rank of officer of the Légion d’Honneur in 2011. The English translation of this text was kindly provided by IHES which is preparing an obituary for Cecile for its next newsletter. There will be an additional obituary for Cecile in the December 2017 issue of Matters of Gravity).

I am happy and proud that Cecile has chosen me to present to her the insignia of an officer of the Légion d’Honneur. France certainly owed Cecile this decoration because she is largely responsible for the renaissance and flourishing, starting in the 1950s, of French theoretical physics, a discipline that had sadly declined because of both the war and the dominating influence of an aging De Broglie.

As everyone knows, Cecile set up the Les Houches Summer School as a compensation for having married a foreigner, Bryce DeWitt. Cecile was able to build this school and run it thanks to her energy, her determination and her understanding of human relations, among others. She led the school for over twenty years and it is still going strong today. Not only did she rescue French theoretical physics from its moribund state, she also trained the greatest physicists around the world: her astuteness in choosing topics and speakers, her clear-sightedness, her courage and tenacity in organizing work and daily living are well known by all physicists and I need not dwell on this subject any further. I will only add here the role Cecile played in the creation of the wonderful Institute that is IHES, founded by the businessman and mathematician, Motchane.

It so happened that Cecile and I were in the same year in fifth grade at the Lycée Victor Duruy in Paris, but in separate sections. I only met Cecile twenty years later, when I went to see her at the Institut Poincaré, on the advice of Georges Darmao, to ask to take part in her summer school for two weeks. The handsome young woman replied very firmly: “the school is all (two months at the time) or nothing.” It was to be nothing.

I only really got to know Cecile at the conference she had organized in 1957 in Chapel Hill, the first one ever held by the General Relativity and Gravitation (GRG) Society. Its founding members were the great relativists of the time: J.A. Wheeler, A. Lichnerowicz, M.A. Tonnelat, P. Bergmann, V.A. Fock,…and of course, Bryce DeWitt. Bryce was a great physicist and a man who loved adventure, one worthy of Cecile, although perhaps not always easy to live with, but Cecile also...
knew how to manage family life - a husband and four daughters - which I also admired. The Chapel Hill conference was, like everything else Cecile does, a great success. It marked the advent of General Relativity as a true physics theory, based on rapidly developing mathematics: analysis on manifolds and non-linear partial differential equations. The GRG Society, created at the instigation of the DeWitts, now has over one thousand members and its triennial conferences are held across the globe, attracting ever increasing numbers of participants.

Having got to appreciate Cecile in Chapel Hill, I invited her to Paris. She gave a series of conferences at the Institut Poincaré on her favorite subject, the Feynman path integral, which fascinated the audience, myself included. Unfortunately, the difficulties of interpreting the Feynman path integral in terms of standard rigorous mathematics were discouraging to someone like me with a more down-to-earth mindset. In contrast, Cecile worked on what was then modern differential geometry and even offered to translate into English a fairly elementary book I had written on the subject. I did not think it worthy of her and I suggested instead that we write together a more comprehensive book that would also contain analysis and applications to physics, which could be used by physicists. That was how we came to write Analysis, Manifolds and Physics and then a second volume, 92 Applications, which became Volume II in a subsequent, expanded edition. It was a great pleasure to write these books with Cecile. She is like me, even more so, in always wanting to learn new things. She is a great worker who likes to take every task to completion, every calculation in complete detail, and every theory in full generality.

But Cecile is also open to suggestions and her friendliness makes it very pleasurable to work with her. Naturally, her remarkable interpersonal and organizational skills also contributed to the completion of our books and their publication, just like they contributed to everything else she undertakes. Unfortunately for me, our different specialties brought an end to our writing together but happily, not to our friendship. Cecile had never given up her research on Feynman’s path integral, which she had started after meeting Dyson and Feynman in the United States; the doctoral thesis that she prepared in Dublin then defended in Paris was on a completely different topic. Cecile, together with her many students, obtained deep and varied results on this beautiful and mysterious integral. A number of them can be found in a book written with Pierre Cartier on functional integration, published by Cambridge University Press. After the passing of Bryce, Cecile also recently had a book published by Springer: The pursuit of Quantum Gravity, memoirs of Bryce DeWitt.

Dear Cecile, it is with my warmest congratulations that I give you the insignia of officer of the Légion d’Honneur.

Remembering Larry Shepley

Richard Matzner, University of Texas at Austin, matzner2@physics.utexas.edu
Melvin Oakes, University of Texas at Austin, oakes@physics.utexas.edu

Lawrence Charles “Larry” Shepley was born August 11, 1939, in Washington, D.C., to Jack Mandel and Ida Bernstein Shepley. Larry’s father was a licensed civil, electrical, and structural engineer, who worked for the Federal Power Commission where he participated in the licensing of many of the large dams on US navigable rivers. Larry attended Woodrow Wilson High School in Washington DC, where he excelled in science and mathematics. Larry graduated from Swarthmore College with a bachelor’s degree in physics in 1961. He earned a master’s degree and a doctorate in physics in 1963 and 1965 from Princeton University, where he studied under John Archibald Wheeler and Charles W. Misner. His dissertation was entitled “SO(3, R)-Homogeneous Cosmologies.” Following a two-year post-doctoral fellowship at the University of California, Berkeley, under Abraham H. Taub, Larry joined the Physics Department at the University of Texas at Austin in 1967 as an Assistant Professor of Physics, and was in 1970 promoted to Associate Professor.

He served the UT Physics Department in several capacities, as Vice-Chair for Graduate Affairs and Graduate Adviser, as Associate Director of the Center for Relativity, as Departmental Minority Liaison Officer, as the Chair of the Teaching Assistant’s Committee, and in other advisory capacities. He was the Chair of the Equal Opportunities Committee of the College of Natural Sciences at UT Austin. He taught classes at all levels, from basic freshman physics for non-science students to specialized graduate courses.

In addition, Professor Shepley served as a member of the organizing committee of the Texas Symposia on Relativistic Astrophysics, as an instructor at theCurso Centroamericano y del Caribe de Fisica, and as a member of the American Physical Society Committee on Civil Defense. He authored or co-authored/edited over 50 scholarly articles and four books.

Professor Shepley retired in 1995 but continued to be active. He was the Chair of the Texas Section of the American Physical Society and a State Contest Director of the University Interscholastic League.

Larry was a longtime member of the Gilbert and Sullivan Society of Austin, serving as a board member and president. Larry loved to travel, visiting all continents, including Antarctica. He died of congestive heart failure on December 30, 2016. He is survived by his sister, Lona Piatiorgorsky, her husband, Joram, their two sons and their grandchildren, and by many friends. At his request, there were no memorial services or ceremonies and no solicitations in his memory. Larry’s final sentiments, in his own style, were, “Farewell and Good Luck.”

Remembering Marcus Ansorg

Bernd Brügmann, Friedrich-Schiller-Universität Jena, bernd.bruengmann@uni-jena.de
Reinhard Meinel, Friedrich-Schiller-Universität Jena, R.Meinel@tpi.uni-jena.de

Additional contributors: Bruno Giacomozzo, Dorota Gondek-Rosińska, Ericourgoulhon, Jörg Hennig, Jose Luis Jaramillo, Rodrigo Panoso Macedo, Gernot Neugebauer, David Petroff, Luciano Rezzolla, Nikolaos Stergioulas, Loic Villain

On December 2nd 2016, our close friend and collaborator Marcus Ansorg passed away peacefully, at his home in Jena, at the age of 45 years. Marcus Ansorg was born on 18th December 1970, in Arnstadt, in the former East Germany. After studying physics at the Friedrich Schiller University of Jena (1990-1994), he obtained a Master of Science in Applied Mathematics at Queen Mary University in London (1995) and was awarded the Lionel Cooper Prize in Mathematics. He completed his Ph.D. work with Gernot Neugebauer in Jena on Timelike geodesic motions in the general-relativistic gravitational field of a rigidly rotating disk of dust (1998), for which he received the dissertation prize of the Friedrich Schiller University.

Marcus spent the following years at the Institute of Theoretical Physics (Jena, Germany), the Center for Gravitational Physics and Geometry (Pennsylvania State University, USA), the Max Planck Institute for Gravitational Physics (Albert Einstein Institute, Potsdam, Germany), and at the Helmholtz Center (Munich, Germany). While still in Jena, he developed novel numerical methods for the solution of
the Einstein field equations with applications to rotating neutron stars and black holes. Marcus used the essence of the equations to be solved to introduce particularly appropriate coordinate transformations in his spectral methods, thus improving the achievable accuracy by several orders of magnitude over previous methods. Later on, the method was used to fully explore the solution space of differentially rotating neutron stars and strange stars in general relativity and to obtain highly accurate initial data for dynamical evolution of such objects. Exploiting the great potential of the newly developed numerical methods and ingenious coordinate mappings, Marcus was able to explore the richness of the space of solutions of rotating and self-gravitating bodies in general relativity. Many of the results obtained in this way, which cover fluid bodies but also black holes, have been collected in an important monograph, *Relativistic Figures of Equilibrium* (CUP, 2012), which is a perfect match, in beauty and rigor, to the classical work of Chandrasekhar *Ellipsoidal Figures of Equilibrium* in Newtonian gravity. A further highlight during these years was his work on initial data for black holes, resulting in one of the most used data sets of its kind in numerical general relativity (e.g., the TwoPuncture code in the Einstein Toolkit).

Besides his artful mastery of numerical techniques, he also achieved important results with analytical methods, in particular in the context of universal properties of black hole-matter configurations.

In 2010, Marcus returned to the Friedrich Schiller University in Jena as Professor of Theoretical Physics / Theory of Gravitation. He was an enthusiastic lecturer and advisor, and his love of science and his productivity in general relativity remained undiminished. During this last period, Marcus shared not only technical knowledge with the members of his group, but also his own principles and philosophy toward the numerical methods employed in the solution of equations. He was not only an advisor, but also a mentor. Not a boss, but a real friend.

In recent years he also successfully applied his numerical methods in quantum field theory and quantum gravity and his ideas will remain alive in future work. Moreover, together with colleagues from Potsdam and Jena, Marcus developed the novel method of fully pseudospectral-time-evolution to study time-dependent processes with very high accuracy.

Besides being an outstanding physicist and mathematician, Marcus was a talented athlete and his capabilities appeared unlimited to anyone practicing sports with him. He derived great pleasure from anyone practicing sports with him. He derived great pleasure from the company of nature and wilderness, which he would explore either with his (actually Bernd Schmidt’s) kayak or on hiking trips with the company of his wife and two sons and friends. He valued family and friendship deeply and was always quick to lend his sincere and well thought through comments, but also his particular humor and his warm smile to any conversation.

Marcus died after a severe illness, which prematurely ended his remarkable life and career. We mourn with his family the loss of a wonderful person and will honor and cherish his memory.