Damour Fest: Adventures in Gravitation

Report of Contributions

https://indico.math.cnrs.fr/e/DamourFest

Contribution ID: **4** Type: **not specified**

Introductory Address

Tuesday, October 12, 2021 1:45 PM (15 minutes)

Presenter: BOURGUIGNON (IN PERSON), Jean-Pierre (Former IHES Director (1994-2013))

Contribution ID: **5** Type: **not specified**

Adventures in Post-Newtonian Theory

Tuesday, October 12, 2021 2:00 PM (30 minutes)

The post-Newtonian approximation to general relativity plays a paramount role in the discovery of gravitational waves by LIGO and Virgo. In this talk, we highlight the seminal contributions from Thibault and review the latest developments concerning the definition of accurate PN templates for gravitational waves.

Presenter: BLANCHET (IN PERSON), Luc (IAP, Paris)

Contribution ID: **6** Type: **not specified**

Analytical and Numerical Relativity Modeling of Binary Neutron Star Mergers (and Some Highlights from Binary Black Holes)

Tuesday, October 12, 2021 4:00 PM (30 minutes)

Ground-based gravitational-wave observations of binary neutron stars (BNS) can, in principle, uncover the entire coalescence process spanning from the low-frequencies (few Hz, low-velocities) inspiral motion to the high-frequencies merger and remnant dynamics (in the kiloHertz regime). These observations hold the promise to deliver unprecedent insights on fundamental aspects of physics and astrophysics, as for example the nature of matter at extreme densities. The main part of this talk summarizes recent efforts towards modeling the complete BNS gravitational-wave spectrum, highlighting current and future application of the model in gravitational-wave astronomy. The last part of the talk reports on recent advances in modeling gravitational-waves from binary black holes (BBH) mergers using the same analytical/numerical relativity approach. The main results concern the construction of faithful waveform models from generic-orbits mergers and a Bayesian analysis of GW190521 that supports the possible first detection of a BBH dynamical encounter in astrophysical context.

Presenter: BERNUZZI (REMOTE), Sebastiano (University of Jena)

Contribution ID: **7** Type: **not specified**

The Path Forward for Gravitational-wave Astrophysics

Tuesday, October 12, 2021 3:00 PM (30 minutes)

The spectacular observation of a wide variety of gravitational-wave sources by Virgo and LIGO has established the field of gravitational-wave astronomy both stand-alone and as an element in multi-messenger astrophysics. There is, however, the clear motivation from the perspective of observational science and also evident paths technically to make significant steps forward in the extent of reach and breadth of frequency. As a diversion from a rich palette of explorations of theory, I'll talk a bit about the roadmap for the field of observations of gravitational waves.

Presenter: SHOEMAKER (REMOTE), David (MIT)

Contribution ID: **8** Type: **not specified**

The Effective-One-Body Approach to the Relativistic Two-Body Problem: from Birth to Adulthood

Tuesday, October 12, 2021 2:30 PM (30 minutes)

After reviewing my adventures in gravitation at IHES in 1997-1999, and the original motivations that led to the development of the effective-one-body formalism, I will discuss the path that guided the development of highly accurate waveform models for LIGO-Virgo's searches and inference studies, including the synergistic interplay between analytical and numerical relativity. I will conclude with highlights on the science that these waveform models have unveiled, focusing on the latest LIGO-Virgo's observing run.

Presenter: BUONANNO (IN PERSON), Alessandra (AEI, MPI, Potsdam)

Contribution ID: **9** Type: **not specified**

Turbulence in One Dimension.

Tuesday, October 12, 2021 4:30 PM (30 minutes)

I will discuss toy models of turbulence which allow to clarify this concept, find a non-Gaussian probability distribution, and establish connections between turbulence, anomalies, and general covariance

Presenter: POLYAKOV (REMOTE), Alexander (Princeton University)

Contribution ID: **10** Type: **not specified**

E10 and the Wave Function of the Universe

Wednesday, October 13, 2021 11:30 AM (30 minutes)

In attempts to formulate a unified theory of quantum gravity and the fundamental interactions of the maximal rank, hyperbolic Kac-Moody algebra E10 plays a distinguished role. In this talk, I will touch on selected aspects of recent work in this direction (much of which has been advanced and inspired by Thibault) and review some of the outstanding issues.

Presenter: NICOLAI (IN PERSON), Hermann (AEI, MPI, Potsdam)

Contribution ID: **11** Type: **not specified**

Ultrarelativistic Limit of Gravity, Spacelike Singularities and E(10)

Wednesday, October 13, 2021 12:00 PM (30 minutes)

Einstein's theory admits interesting limits with different causal structures obtained by letting the speed of light go to infinity (Galilean or "non-relativistic" limit) or to zero (Carrollian, or "ultra-relativistic" limit). In the latter case, instead of the hyperbolic partial differential equations of general relativity and the elliptic differential equations of Newton's theory, the dynamical equations become ordinary differential equations with respect to time. The ultrarelativistic limit turns out to be relevant near spacelike (cosmological) singularities when spatial gradients become subdominant. The resulting differential equations possess a remarkable interpretation in terms of infinite-dimensional Kac-Moody algebras. The talk will discuss work pursued in collaboration with Thibault Damour on this topic, as well as some aspects of Carroll invariant theories.

Presenter: HENNEAUX (IN PERSON), Marc (Collège de France & ULB Bruxelles)

Contribution ID: **12** Type: **not specified**

Gravitational Radiation in General Spacetimes

Wednesday, October 13, 2021 2:30 PM (30 minutes)

Gravitational waves transport information from faraway regions of the Universe. Studies of gravitational waves have been devoted mostly to sources such as binary black hole mergers or neutron star mergers, or generally sources that are stationary outside of a compact set. These systems are described by asymptotically-flat manifolds solving the Einstein equations with sufficiently fast decay of the gravitational field towards Minkowski spacetime far away from the source. Waves from such sources have been recorded by the LIGO/VIRGO collaboration since 2015. Thibault Damour has made vast contributions to this field of research. In this talk, I will present new results on gravitational radiation for sources that are not stationary outside of a compact set, but whose gravitational fields decay more slowly towards infinity. A panorama of new gravitational effects opens up when delving deeper into these more general spacetimes. In particular, they generate new structures in gravitational radiation and memory. These are deeply connected with an "appealing story of non-peeling" curvature and geometric components. The new effects emerge naturally from the Einstein equations both in the Einstein vacuum case and for neutrino radiation. The latter results are important for sources with extended neutrino halos.

Presenter: BIERI (REMOTE), Lydia (Michigan University)

Contribution ID: **13** Type: **not specified**

An Intriguing Puzzle and its Happy Resolution

Wednesday, October 13, 2021 3:00 PM (30 minutes)

At the end of 2018, a result by Bern et al. on gravitational scattering at order G^3 raised an intriguing puzzle that got more and more embarrassing for about 20 months. Its eventual resolution made everyone, and particularly Thibault, happy. I will give a brief account of that amusing story.

Presenter: VENEZIANO (REMOTE), Gabriele (CERN & Collège de France)

Contribution ID: **14** Type: **not specified**

Black Holes and Wormholes in Semiclassical Gravity

Wednesday, October 13, 2021 12:30 PM (30 minutes)

In this talk, I will discuss whether the black hole metric remains to be a solution of gravitational equations provided the classical gravitational action is modified by the generally non-local terms after integrating out the quantum matter. The story appears to be dramatically different for the Hartle-Hawking state and for the Boulware state. The discussion will be based on the analysis of the 2d RST model and the 4d theory with a CFT as the quantum matter.

Presenter: SOLODUKHIN (IN PERSON), Sergey (University of Tours)

Contribution ID: **15** Type: **not specified**

Discrete Gravity

Wednesday, October 13, 2021 2:00 PM (30 minutes)

We assume that the points in volumes smaller than an elementary volume (which may have a Planck size) are indistinguishable in any physical experiment. This naturally leads to a picture of a discrete space with a finite number of degrees of freedom per elementary volume. In such discrete spaces, each elementary cell is completely characterized by displacement operators connecting a cell to the neighboring cells and by the spin connection. We define the torsion and curvature of the discrete spaces and show that in the limiting case of vanishing elementary volume the standard results for the continuous curved differentiable manifolds are completely reproduced.

Presenter: MUKHANOV (REMOTE), Viatcheslav (Ludwig Maximilian University, Munich)

Contribution ID: **16** Type: **not specified**

Cosmic Strings and Spinning Black Holes

Wednesday, October 13, 2021 4:00 PM (30 minutes)

A large cosmic string loop captured by a much smaller black hole oscillates on a nearly periodic orbit. The orbit slowly evolves due to energy and angular momentum exchange between the loop and the black hole. For a non-rotating black hole, the loop gradually loses its energy due to the friction of the moving string against the horizon. But for a spinning black hole, the loop energy can greatly increase by extracting the rotational energy of the black hole. The loop evolution is mathematically equivalent to the continuous deformation of a curve in 3D, described by a simple equation. We explore possible asymptotic states of this evolution and show that they are strong emitters of gravitational waves. Finally, we find that string loops are very likely to be captured by supermassive black holes at galactic centers for a wide range of string parameters.

Presenter: VILENKIN (IN PERSON), Alex (Tufts University)

Contribution ID: **17** Type: **not specified**

Modeling the Many Microbes Inside Us

Wednesday, October 13, 2021 4:30 PM (30 minutes)

Microbial communities, from plankton to the human microbiome, present similar community structures. They are for instance composed of many rare species and a few abundant ones. How a large number of species can coexist in those complex communities and why they are dominated by rare species is still not fully understood. Those communities also present similar dynamical behavior. To study the dynamics of microbial communities, we analyzed the properties of various experimental time series and looked for their common characteristics. We investigated whether the most popular model for ecosystem modeling, namely the (stochastic) generalized Lotka-Volterra models, could reproduce those properties. We showed that this is the case upon certain conditions. In particular, the noise in the growth rates of the various species should be large, meaning that environmental noise is dominant at the observed timescale. Moreover, we showed that if we add a global maximal capacity, representing the limited available resources, the heavy-tailed abundance distributions arise as an emergent property. The long-term goal in the field is to build predictive dynamical models, and eventually to be able to control community composition - and especially to understand how to restore healthy flora in case of disease.

Presenter: DE BUYL (IN PERSON), Sophie (VUB)

Contribution ID: **18** Type: **not specified**

Complex Metrics on Spacetime

Wednesday, October 13, 2021 5:00 PM (30 minutes)

For a variety of reasons, it seems necessary to consider complex saddle points in the "Euclidean" approach to black hole thermodynamics. But what class of complex saddle points is physically sensible? That will be the subject of this talk.

Presenter: WITTEN (REMOTE), Edward (IAS, Princeton)

Contribution ID: **19** Type: **not specified**

Higher-order Post-Newtonian ADM Dynamics of Compact Binary Systems: a DJS "Tour de Force"

Thursday, October 14, 2021 11:30 AM (30 minutes)

I will present the role of Thibault Damour ('D'in 'DJS') and his colleagues ('S'and 'J'in 'DJS') in initiating, at the turn of the millennium, calculations of higher-order Post-Newtonian (PN) corrections to the equations of motion of compact binary systems. DJS derived for the first time complete and error-free dynamics of compact binary systems in the 3PN and 4PN orders, and to achieve this, they –also for the first time –successfully applied dimensional regularization to UV divergencies and linked the IR near-zone divergencies to the tail effects. I will conclude with a look at the future of PN computations performed in the traditional, i.e. "à la DJS", manner

Presenter: JARANOWSKI (REMOTE), Piotr (University of Białystok)

Contribution ID: **20** Type: **not specified**

MPM-PN Explorations of Inspiraling Compact Binaries: Down Indo-French Memory Lane

Thursday, October 14, 2021 12:00 PM (30 minutes)

The talk is a personal recall of my involvement in projects related to gravitational waves from inspiraling compact binaries with colleagues in France. In particular, a summary of aspects related to eccentric binaries pursued in my group.

Presenter: IYER (REMOTE), Bala (ICTS, TIFR, Bangalore)

Contribution ID: **21** Type: **not specified**

Inflationary Scalar and Tensor Hair

Thursday, October 14, 2021 12:30 PM (30 minutes)

All inflationary models, in spite of locally approaching the de Sitter space-time inside the Hubble radius, have scalar and tensor 'hair'–spatial inhomogeneity - outside it. This inhomogeneity does not disappear with time. Just the opposite, its amplitude at a given comoving scale typically remains constant not only during inflation but a long time after its end up to the moment of the second Hubble radius crossing of this scale. Moreover, a part of these scalar inflationary hairs have been already observed through measurements of CMB angular temperature anisotropy and polarization, and we expect the discovery of tensor hairs (primordial gravitational wave background from inflation) in the future. In terms of 'no-hair'theorems, this situation is similar but just opposite to that in General Relativity (GR), where we have the 'no-hair'property of black holes outside their event horizons, but not inside them. I consider the structure of these hairs in different classical and one-loop quantum models in GR and modified gravity both in linear and non-linear regimes. The description of scalar quantum hair in the non-linear regime during inflation is possible in the closed-form in the scope of the stochastic inflation formalism using the Fokker-Planck equation.

Presenter: STAROBINSKY (REMOTE), Alexei (Landau Institute, Moscow)

Contribution ID: **22** Type: **not specified**

On the Nature of the Ultrarelativistic Prompt Emission Phase of GRB 190114C and GRB 180720B

Thursday, October 14, 2021 3:00 PM (30 minutes)

We address the physical origin of the ultra-relativistic prompt emission (UPE) phase of GRB 190114C and GRB 180720B. We assume that during the UPE phase, the "inner engine"of the GRB, composed of a Kerr black hole (BH) and a uniform test magnetic field B_0, aligned with the BH rotation axis, a Wald - Papapetrou solution operates in an overcritical field |E| ≥ E_c, where E_c = m^2_ec^3 / (e ħ), being m_e and -e the mass and charge of the electron. We infer an e^+e^- pair electromagnetic plasma in presence of a baryon load, a PEMB pulse, originating from a vacuum polarization quantum process in the inner engine. This modifies both the boundary conditions and the physics interpretation of the pioneering work of Damour-Ruffini 1975. The new process determine the time-varying mass and spin of the Kerr BH in the inner engine, fulfilling the Christodoulou-Hawking-Ruffini mass-energy formula of a Kerr BH. For the first time, we quantitatively show how the inner engine, by extracting the rotational energy of the Kerr BH, produces a series of PEMB pulses and the overall GRBs MeV emissions (detailed in Phys. Rev. D: https://doi.org/10.1103/PhysRevD.104.063043).

Presenter: RUFFINI (IN PERSON), Remo (ICRA, Rome)

Contribution ID: **23** Type: **not specified**

Membrane paradigm and fluid/gravity correspondence

Thursday, October 14, 2021 2:30 PM (30 minutes)

Damour has been one of the first to suggest that the dynamics of a black hole's horizon could be interpreted as the motion of a fluid, thus inspiring what became known as the membrane paradigm. I will review his seminal contribution and the more modern developments, originating from the holographic duality, that have led to a more systematic understanding of the connections between gravity and fluid dynamics

Presenter: POLICASTRO (IN PERSON), Giuseppe (ENS Paris)

Contribution ID: **24** Type: **not specified**

Recent Breakthroughs in Gravitational Self-force

Friday, October 15, 2021 12:00 PM (30 minutes)

Gravitational self-force theory provides a natural method of modeling binaries with small mass ratios. By expanding the binary's metric around the background metric of the larger body, this approach greatly simplifies the binary problem while remaining accurate in the highly relativistic regime. In this talk, I summarize the foundations of self-force theory, how it leads to an elegant two-timescale description of the binary problem, and the current state of the art. I particularly focus on two recent breakthroughs: a two-timescale expansion of the field equations for generic orbital configurations, which enables rapid "post-adiabatic" waveform generation at second order in the binary's mass ratio; and the first calculation of post-adiabatic waveforms. The post-adiabatic waveforms are found to agree well with full numerical relativity waveforms even for mass ratios close to 1, showing that this small-mass-ratio method can be accurate well outside the small-mass-ratio regime.

Presenter: POUND (IN PERSON), Adam (University of Southampton)

Contribution ID: **25** Type: **not specified**

On the Nonlinear Stability of the Kerr Metric

Thursday, October 14, 2021 5:00 PM (30 minutes)

I will give a status report on the stability of Kerr conjecture and focus on my recent results with J. Szeftel and E. Giorgi concerning the case of small angular momentum.

Presenter: KLAINERMAN (IN PERSON), Sergiu (Princeton University)

Contribution ID: **26** Type: **not specified**

On the Black Hole/String Transition

Thursday, October 14, 2021 4:30 PM (30 minutes)

It has been proposed that a small enough black hole in string theory would transition into a hot oscillating string. We explore whether this transition can happen smoothly in classical string theory. We find evidence that this is the case in the heterotic string theory, but not in the type II string theory.
The talk is based on a recent paper by Yiming Chen, JM, and Edward Witten: https://arxiv.org/abs/2109.08563

Presenter: MALDACENA (REMOTE), Juan (IAS, Princeton)

Contribution ID: **27** Type: **not specified**

Hommage à Thibault : ”Some Old Lessons from GR”

Tuesday, October 12, 2021 5:00 PM (30 minutes)

Presenter: DESER (REMOTE), Stanley (Brandeis University)

Contribution ID: **28** Type: **not specified**

A Space Test of the Equivalence Principle with MICROSCOPE

Friday, October 15, 2021 11:30 AM (30 minutes)

One century ago, Einstein revealed his theory of gravity which shook the foundations of physics. General Relativity (GR) is a revolutionary concept that is not very intuitive for most people. As a pillar of the GR, the weak equivalence principle (WEP) leads to the universality of free-fall historically attached to Galileo Galilei. Because the WEP is a cornerstone of the GR, its test was particularly intensified since the second half of the twentieth century with essentially two types of experiments: the Bessel/Eötvös Pekár type pendulum developed by the Eöt-Wash group and the Lunar laser ranging measurements. Testing the EP in space was fist devised by Chapman and then widely developed by Everitt's team at Stanford University. The basic idea was to take advantage of calm environments in space to access micro-gravity or better say nano-gravity. In 1999, ONERA and OCA proposed a mission with a performance objective easier to achieve than previously imagined. This mission called MICROSCOPE was developed as part of the CNES Myriad microsatellite line. It was launched in April 2016 and ended its operations in October 2018. Onera was in charge of the scientific instrument development. In close cooperation, OCA and ONERA collected useful data which already place the precision of the EP test at some 10^14 in 2017 with only 7% of the data.
The final results are very close to being published. Extensive verification work has been carried out since the first publication in order to establish the systematic errors. The data process of glitches in the measurement, produced by satellite cracking, was also a difficult task. While awaiting for the final result paper review, the presentation will provide an overview of the mission with particular emphasis on some results of the data processing strategy.

Presenter: RODRIGUES (IN PERSON), Manuel (ONERA, Université Paris-Saclay)

Contribution ID: **29** Type: **not specified**

Almost 50 Years of Probing Strong-field Gravity with Pulsars - and Still Going Strong

Thursday, October 14, 2021 4:00 PM (30 minutes)

We experience a golden era in testing and exploring relativistic gravity using gravitational wave detectors, satellites, lab experiments, and also radio astronomical observations. Here, especially binary pulsars provide us with complementary insight. Having provided the first evidence for gravitational waves, pulsars continue to allow probing relativistic strong-field effects - within a framework co-designed by Thibault Damour - that cannot be studied by other means. This talk will present an overview and the latest results of high-precision measurements that go beyond the previous state-of-art, giving access both to studies of relativistic gravity as well as neutron star properties.

Presenter: KRAMER (REMOTE), Michael (MPI, Bonn)

Contribution ID: **30** Type: **not specified**

Impact and Legacy of the 2010 Paper on Self-force and EOB

Friday, October 15, 2021 12:30 PM (30 minutes)

In a visionary 2010 paper, T. Damour identified the potential of self-force calculations to inform the construction of a strong-field two-body Hamiltonian in general relativity.
The paper, in a way, foretells much of the history of self-force work in the decade that followed. Six self-force calculations were proposed, each providing a handle on a distinct aspect of the strong-field conservative dynamics. Five of these calculations have been performed so far, paying handsome dividends. The sixth calculation is the focus of intense current effort. This talk will give a perspective on the long-lasting legacy of the 2010 paper.

Presenter: BARACK (REMOTE), Leor (University of Southampton)

Contribution ID: **31** Type: **not specified**

”Rustic buffet”

Wednesday, October 13, 2021 6:00 PM (1h 30m)

Opening address by Emmanuel Ulmo, IHES Director (around 15 mn)

Contribution ID: **32** Type: **not specified**

Nom de la personne

TITRE
description