Lightning talks

Time	Author	Title
Thursday 1:00pm – 1:07pm	Zachariah Etienne	SENR/NRPy: A Next-Generation, Dynamical Reference Metric Numerical Relativity Code
Thursday 1:07pm – 1:14pm	Vassili Mewes	Spherical BSSN with the ET
Thursday 1:14pm – 1:21pm	Alberto Santos Morales	A supervised learning approach to estimate parameters of binary black holes from gravitational waveforms
Thursday 1:21pm – 1:28pm	Qian Zhang	Practices on how to manage and share research data
Friday 9:00am – 9:07am	Qian Zhang	DataVault: An Einstein Toolkit Data Repository – Design update
Friday 9:07am – 9:14am	Andre da Silva Schneider	An Open-Source Nuclear Equation of State Code for Astrophysical Simulations
Friday 9:14am – 9:21am	Shohreh Abdolrahimi	Spectral Methods in General Relativity and Large Randall-Sundrum II Black Holes
Friday 9:21am – 9:28am	Yosef Zlochower	Evolving Highly-Spinning Black-Hole Binaries Using the Einstein Toolkit
Friday 9:30am – 9:37am	Francesco S. Guzman	Magnetic reconnection on the solar atmosphere and GRBs from progenitors: using Cactus
Friday 9:37am – 9:44am	Eloisa Bentivegna	Cosmology with the ET
Friday 9:44am – 9:51am	Jonah Miller	Shock Capturing with Spectral Methods
Friday 9:51am – 9:58am	Dan Johnsons	POWER – An Open-Source Python based waveform extractor

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Thursday

Zachariah Etienne: SENR/NRPy: *A Next-Generation, Dynamical Reference Metric Numerical Relativity Code*

The Super-Efficient Numerical Relativity (SENR) code is designed to be at least 100x more memory efficient than AMR-based codes for compact binary modeling. It accomplishes this through curvilinear numerical grids that contain coordinate singularities, adopting and extending the reference metric formalism of Baumgarte et al (https://arxiv.org/abs/1211.6632) for BSSN in spherical polar coordinates. Baumgarte is a collaborator on the SENR project. NRPy is a fully BSD-licensed alternative to Kranc, based entirely on Python and SymPy (Python 2.4+ or 3+). NRPy is capable of converting sets of expressions expressed in Einstein notation directly to highly-efficient C code at arbitrary finite difference order. SENR depends on NRPy to generate the BSSN equations in arbitrary reference metrics, with minimal user input. NRPy also generates the C code for the BSSN evolution equations in the BSSN-in-Spherical-Coordinates thorn, Vassilios Mewes lead developer. I will present an overview of both codes, as well as latest progress. SENR/NRPy are both open source (BSD-licensed) and open development: http://tinyurl.com/senrcode

Vassili Mewes: *Spherical BSSN with the ET*

I will give an overview of our efforts to implement the BSSN equations in 3D spherical coordinates (Baumgarte et. al. 2013) without symmetry assumptions in the Einstein Toolkit, describing our implementation of MPI parallelised symmetry-parity boundary conditions using the existing infrastructure of the toolkit, the actual implementation that uses the BSSN RHS generated by the SENR code, interfaces to existing diagnostics thorns as well as some first code tests. I will also provide an overview of our complimentary ongoing work on Patchwork, a new multipatch infrastructure for multiphysics/multiscale/multiframe fluid simulations.

Alberto Santos Morales: *A supervised learning approach to estimate parameters of binary black holes from gravitational waveforms*

In less than two years Laser Interferometer Gravitational-wave Observatory (LIGO) has reported three direct detections of gravitational waves (GW) from binary black-holes

(BBH). Detection of GW consists on measuring and identifying small deformations of the space-time (i.e., strain) that are produced by astronomical massive objects. The inverse problem in GW consists on identify the astrophysical source parameters, e.g., mass ratio, spin, distance, orbital phase, among others. This work proposes to estimate the mass ratio of colliding BBH using an algorithm that is trained with a dataset of gravitational waveforms created from numerical relativity (NR). Preliminary results indicate a mean square error (MSE) of 0.2 solar masses in the estimations and a correlation coefficient of 0.85 between the estimations and the parametrical data. This approach can be applied to characterize GW from strong sources as the GW150914. We conclude that it is possible to use a supervised learning approach to estimate parameters of BBH from GW waveforms.

Qian Zhang: *Practices on how to manage and share research data*

This session aims to provide you with data management best practices and tools to increase your research efficiency and impact. I'd like to give a quick review on smart and simple data management, including data management requirements & mandate, practices, reality, and most importantly a basic introduction to the elements of good data management using a data management plan framework, and discuss how to find and vet resources for making data publicly accessible.

Friday

Qian Zhang: *DataVault: An Einstein Toolkit Data Repository – Design update*

In this talk, I'd like to introduce the infrastructure design of the dedicated domain data repository - DataVault, which is oriented to support activities within the Einstein Toolkit Consortium that expands our contributions within LIGO and the numerical relativity community. I will use a real simulation dataset that is generated by the Einstein Toolkit to illustrate the interface design mockup for data deposit, sharing, re-use, and online data analysis and visualization.

Andre da Silva Schneider: *An Open-Source Nuclear Equation of State Code for Astrophysical Simulations*

The equation of state (EOS) of dense matter is an essential ingredient for numerical simulations of core-collapse supernovae and neutron star mergers. The properties of matter near and above nuclear saturation density are uncertain, which translates into uncertainties in astrophysical simulations and their multi-messenger signatures. Therefore, a wide range of EOSs spanning the allowed range of nuclear interactions are necessary for determining the sensitivity of these astrophysical phenomena and their signatures to variations in input microphysics. We present a new set of finite temperature EOSs based on experimentally allowed Skyrme forces. We employ a liquid drop model of nuclei to capture the non-uniform phase of nuclear matter at sub-saturation density, which is blended into a nuclear statistical equilibrium EOS at lower densities. We also provide a new, open-source code for calculating EOSs for arbitrary Skyrme parametrizations. We then study the effects of different Skyrme parametrizations on thermodynamical properties of dense astrophysical matter, the neutron star mass-radius relationship, and the core collapse of 15 and 40 solar mass stars.

Shohreh Abdolrahimi: *Spectral Methods in General Relativity and Large Randall-Sundrum II Black Holes*

Using a novel numerical spectral method, we have found solutions for large static Randall-Sundrum II (RSII) black holes by perturbing a numerical AdS_5-CFT_4 solution to the Einstein equation with a negative cosmological constant Lambda that is asymptotically conformal to the Schwarzschild metric. We used a numerical spectral method independent of the Ricci-DeTurck-flow method used by Figueras, Lucietti, and Wiseman for a similar numerical solution. We have compared our black-hole solution to the one Figueras and Wiseman have derived by perturbing their numerical AdS_5-CFT_4 solution, showing that our solution agrees closely with theirs. We have also deduced the new results that to first order in $1/(-\Lambda\ M^2)$, the Hawking temperature and entropy of an RSII static black hole have the same values as the Schwarzschild metric with the same mass, but the horizon area is increased by about $4.7/(-\Lambda)$.

Yosef Zlochower: *Evolving Highly-Spinning Black-Hole Binaries Using the Einstein Toolkit*

We recently developed a code for solving the 3+1 system of constraints for highly-spinning black-hole binary initial data in the puncture formalism. Here we explore how different choices of gauge can be used to efficiently evolve binaries with near maximal spins.