

Summary Talk

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Thanks

- I am indebted to the local organizers for the invitation to give the summary talk. It forced me to attend, and pay attention to, all of the talks. A task **exhausting** and at the same time **invigorating**.
- I apologize to the 15 mins speakers. I will not review their talks.
- I would also like to thank **K. G. Arun** and **Dhiraj Hazra** for suggestions and helpful advice during the preparation of this talk.

Hosts

- Centre for Strings, Gravitation and Cosmology, Department of Physics, IIT Madras.
- Indian Institute of Technology Madras, Chennai
- Chennai Mathematical Institute, Chennai
- The Institute of Mathematical Sciences, Chennai
- SOC: Dhiraj Kumar Hazra, Jerome Martin, B. S. Sathyaprakash, L. Sriramkumar, Sumati Surya, Amitabh Virmani.

L. Sriramkumar

His contribution to this event stands out. 1000+ emails to coordinate such an event.

Aims of symposium

- To highlight Chennai as an attractive place to do research in classical and quantum gravity, gravitational wave physics, and cosmology.
- To provide exposure to graduate students and post-doctoral fellows to the recent developments in these areas.
- 30 mins talks: to provide younger colleagues an (international) forum to showcase their work.

Successful

We all would agree that we have been successful with the above goals.

General Comments

- The talks at symposium were of **extremely high quality**, both in terms of the interest of the material presented and the clarity of the presentations.
- I have tried to give equal attention to all speakers, but given my limitations, I may have done a less than perfect job.

General Comments

- 14 long talks, 12 short talks, and 1 special lecture.
- First impression: The community in India (Chennai) is very vibrant. The discussion at the meeting were quite diverse ranging from numerical codes in GR to quantum aspects in black hole physics.
- I will give a concise scientific summary of the talks and make some broad comments.
- Three main themes: Classical and Quantum Gravity, Gravitational Waves, and Cosmology.

Disclaimer



Misrepresentation is unavoidable.

Special Chandrashekhhar lecture

Kandaswamy Subramanian

The Earth, Sun, galaxies, galaxy clusters, even intergalactic medium host coherent magnetic fields. How do these systems get magnetized? Two main ideas: cosmic dynamos and magnetogenesis. Pedagogical review of both these paradigms, highlighting current challenges and future prospects.

Pedagogy

Students loved it.

Classical Gravity

Beatrice Bonga

She started with a review of asymptotic flatness from a geometrical perspective. Showed that it is entirely equivalent to coordinate based Bondi-Sachs approach. Gravitational waves in FRW spacetimes.

Sk Jahanur Hoque

Spoke on various technical developments on de Sitter Bondi-Sachs approach.

Classical Gravity

Srijit Bhattacharjee

Gave a review talk on supertranslations at black hole horizons. He also reviewed gravitational memory in the modern context of Strominger's infrared triangle.

Aaron Held

Black holes beyond general relativity: shadows, stability, and nonlinear evolution. Going beyond the null tests. He introduced principle-parameterised approach. High powered numerical relativity work.

Classical/Quantum Gravity

Alok Laddha

Gave an overview of the infrared triangle. He focused on the classical limits of the quantum soft theorems and how they can be interpreted in the classical theory as memory effects.

Dawood Kothawala

Gave a thought-provoking talk on incorporating minimum length in theories of gravity, in particular ideas on reconstructing spacetime geometry from non-local bi-tensors which naturally capture minimum length scenarios.

Quantum Gravity

Eugenio Bianchi

Gave a very comprehensible talk on the link between quantum gravity and quantum information. He highlighted the puzzle of black holes and how simple quantum spin system models can be used to learn about deeper black hole issues.

Eleni-Alexandra Kontou

She began with a review of classical singularity theorems. Then she gave the statement of a quantum strong energy inequality and of a semi-classical singularity theorem for minimally coupled massive scalar field. Finally, she discussed the smeared energy conditions.

Quantum fields

Atsushi Higuchi

He started with a very understandable review of de Sitter spacetime. Analytic continuation from Euclidean to thermal field theory. Hartle-Hawking (thermal) state in the static patch of de Sitter spacetime. KMS state = Hartle-Hawking.

Vincent Vennin

Structure formation by the gravitational amplification of quantum fluctuations is a widely accepted idea. Can we prove that cosmic structures are of quantum mechanical origin? He talked about quantum discord. Large quantum discord in Fourier space but suppressed in real space.

Gravitational waves

K. G. Arun

Gave an overview of the variety of tests of GR. At present, GW observations are consistent with GR.

Shilpa Kasta

She focused on black hole spectroscopy. GW190521 contains a loud measurable (3,3) ringdown quasi-normal mode. The remnant object is consistent with a Kerr black hole.

Together & other talks

Several tests are being performed on every GW event. Understanding the relationship between these tests will help to make precise any claim of a deviation from GR (if found) stronger.

Gravitational waves

Anuradha Gupta

What are the astrophysical environments in which binary black hole mergers take place? A higher mass gap is theoretically expected, but no evidence is found. No evidence for a lower mass gap either.

Vishal Baibhav

The origin of binary black holes. Two main scenarios: binary evolution & dynamical formation. The agreement of these two scenarios with the data was discussed.

Gravitational waves

Rahul Kashyap

He spoke on binary neutron star mergers. The subject is complex. Several outcomes are possible. He discussed the scenario of prompt collapse to black hole.

Surabhi Sachdev

She started with an overview of the gravitational-wave sources and detectors. She gave a concise and very clear overview of observations so far and methods used in GW science.

Gravitational waves

Anuradha Samajdar

Gravitational waves emitted from the coalescence of neutron star binaries open a new window to probe matter and fundamental physics. She spoke on the constraints on the neutron star equation of state from future gravitational wave observations.

Numerical GR

Prayush Kumar

He emphasized the importance of numerical simulations for gravitational wave astronomy. He gave a summary of initial value formulation of GR and an overview of how the numerical simulations work. Modern and future looking codes.

Inspiring

This is the first talk I heard on numerical simulations from a faculty in India.

Gravitational waves & beyond

Mairi Sakellariadou

Gravitational waves background can be used to constraint quantum gravity candidate theories.

Guillem Domenech

He gave a review of gravitational waves induced by primordial fluctuations, specifically connection with primordial black holes. Can provide tests for physics at inflation (power spectrum) and physics after inflation.

Cosmology

Sebastian Clesse

Primordial black holes mass and abundance is a hot topic of discussion. There are hints that solar mass black holes can be primordial. Are PBH participating in mergers? Intriguing but not conclusive.

Rajeev Jain

Gave an introduction to the subject of magnetic fields in the Universe. Then he discussed cosmological imprints of dynamical gauge fields during inflation. Towards the end, he discussed the calculation of primordial correlation of gravitons with an abelian gauge field.

Cosmology

Arman Shafieloo

Gave a review of the Hubble and related tensions. Modify dark energy models? Modify the primordial spectrum? Many theoretical/phenomenological models are proposed to ease the tensions, none is convincing so far.

Main message

Not possible to resolve all problems with minimal modification of the standard cosmological model.

Cosmology

Tirthankar Roy Choudhury

Detecting the first galaxies. Probing distribution of neutral hydrogen we can know learn about first galaxies.

Suvodip Mukherjee

We can learn a lot in Cosmology by combining Gravitational Wave and Electromagnetic observations. Cross-correlation of GW sources with galaxies.

Cosmology

Debaprasad Maity

Reheating is a poorly understood phase. He proposed a gravitational reheating scenario. Where are how the information about reheating is imprinted? How to rule out such a scenario?

Thank you

- Thanks for all the wonderful talks and stimulating conversations. My apologies to anyone whose work I have inadvertently omitted or misrepresented....[I have limitations]
- The organisation and hospitality were excellent.
- On behalf of all participants I would like to thank the entire Chennai gravity community for this wonderful experience.
- Especially [Sriram](#) who shouldered most of the responsibility in his characteristically [considerate](#) and [efficient](#) manner.

The conference was very widely attended



Thanks. See you all at the 3rd symposium.