Contribution ID: **84** Type: **talk**

Gravitational Waves: A Decade of Exploring the Universe

Monday 1 September 2025 09:00 (50 minutes)

Over the past ten years, the LIGO and Virgo observatories—and now KAGRA—have transformed gravitational-wave detection from an audacious dream into a powerful and routine window onto the cosmos. This talk will retrace that remarkable journey, beginning with the historic first detection of GW150914 on September 14, 2015—a breakthrough that inaugurated gravitational-wave astronomy and forever changed our view of the universe. I will highlight the extraordinary technical innovations that made this possible: kilometer-scale interferometers capable of sensing distortions smaller than a proton, quantum "squeezing"to tame fundamental noise, and exquisitely engineered mirror suspensions that overcome Earth's restless seismic activity. The talk will then showcase the most exciting scientific results from the LIGO-Virgo-KAGRA network—from the spectacular GW170817 binary neutron star merger that launched multi-messenger astronomy, to recent detections of intermediate-mass black holes that challenge our understanding of stellar evolution. Looking forward, I will present the roadmap for upcoming observing runs and upgrades, designed to push sensitivity to new frontiers and dramatically expand the number and diversity of detections. Finally, we will peer into the coming decades of gravitational-wave astronomy, exploring how next-generation observatories such as the Einstein Telescope and Cosmic Explorer—and ambitious space missions like LISA—will probe cosmological distances, illuminate the nature of black holes and neutron stars, and even offer glimpses into the earliest moments of the universe.

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Session Classification: Morning