



Contribution ID: 25

Type: **Oral presentation**

# Contributory: The Ringdown and the Tide: Fingerprints of Dark Matter Halo Profiles

*Tuesday, 17 November 2026 17:00 (15 minutes)*

Astrophysical black holes are expected to reside in environments enriched by dark matter, raising the possibility that environmental effects may leave observable imprints on gravitational-wave signals. We investigate how the structure of a surrounding dark-matter halo modifies both the ringdown and tidal response of a static, spherically symmetric black hole. The halo is modelled using a generalized  $(\alpha, \beta, \gamma)$  density profile within the Einstein cluster framework. We compute the quasinormal mode spectrum and static axial tidal Love numbers, and examine their dependence on the halo compactness and density profile. We show that the halo induces a characteristic redshift of the quasinormal frequencies and damping rates, with the strongest influence arising from the inner halo structure. Time-domain evolutions confirm the frequency-domain results and exhibit late-time tails whose behaviour is governed by the outer density profile. We further demonstrate that the tidal Love number probes the halo through a different radial weighting than the ringdown spectrum, making the two observables complementary. Our results suggest that combining ringdown and tidal measurements can help constrain the spatial distribution of dark matter around black holes and distinguish environmental effects from genuine deviations of the vacuum black-hole geometry.

**Primary author:** CHOWDHURY, Avijit (Indian Institute of Astrophysics)

**Presenter:** CHOWDHURY, Avijit (Indian Institute of Astrophysics)