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From data acquisition to noise mitigation, environmental sensor arrays in Gravitational-Wave Observatories

Gravitational-wave observatories increasingly rely on sophisticated environmental sensor arrays to characterize and mitigate noise sources that couple into interferometric detector measurements. As detectors such as Advanced LIGO and Virgo continue to reach higher sensitivities, a comprehensive set of noise-reduction strategies ranging from passive isolation to active suppression is required to control environmental disturbances and enhance detector performance. There are two low-frequency noise sources which are significant, seismic and infrasound, which together generate Newtonian noise. Starting around 2020, the Virgo observatory deployed an extensive network of seismic sensors specifically designed to support Newtonian-noise studies and mitigation efforts. Complementary environmental sensor arrays provide the spatially resolved data necessary to reconstruct local pressure gradients and ground motion. When combined with precise timing distribution systems, these measurements enable detailed modeling of density perturbations and their impact on the detector test masses.

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