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Effect of Vera C. Rubin Observatory Filter and Return Time Selections on Kilonovae Detectability

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The discovery of the optical/infra-red counterpart to the neutron binary merger gravitational wave detection (GW170817), which followed a short gamma-ray burst (GRB170817), was a groundbreaking moment in multi-messenger astronomy. It is, to date, the only confirmed joint detection of its kind, though many projects are currently developing wide-field surveys to find more electromagnetic counterparts, known as kilonovae, or similar fast-fading transients. Binary neutron-star mergers are notable astrophysical phenomena; they offer us an opportunity to examine various processes, including astrophysical heavy-element nucleosyntheses, merger-driven mass ejections, wide spectrum electromagnetic emissions, and now gravitational waves. However, developments in these areas require the improvement of kilonova detection methods from varied samples of sources. But this is a rather difficult task because kilonovae are faint and fast fading.
Fortunately, the Vera C. Rubin Observatory (VRO) provides excellent prospects for identifying kilonova candidates either from or independent of gravitational-wave and gamma-ray burst triggers. Its 10-year project called the Legacy Survey of Space and Time (LSST) will conduct surveys of various celestial objects and phenomena and explore an exceptional volume of the sky in 6 photometric filters. Indeed, LSST has the potential to make detecting kilonovae amongst a sea of transients easier and thus open the world of fast transient science at excellent depth. Cadence choices for LSST surveys are especially important for maximizing detections.
In this work, we explore the possibility of optimizing the Vera C. Rubin Observatory ability to detect kilonovae to by studying LSST cadences provided by the project, subsequently studying how detection rates are affected by filter selections, notably red/IR filters (i, z, y) compared to bluer filters (u, g, r), the return timescales for visits of the same area in the sky, and other relevant factors. We assess the benefit of our findings to related scientific interests, including maximizing a range of fast transient discoveries.

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