Example "Science Pitches" for Roman-Rubin Synergies in General Astrophysics

Suvi Gezari

Pinpointing the environments and hosts of Rubin-discovered transients with Roman imaging

What are the progenitors and/or central engines of cosmic explosions?

The classification of extragalactic transients can benefit from pinpointing their location within their host galaxy. For example, if a transient is localized to be coincident with the center of a galaxy, then that transient becomes likely associated with the galaxy's central supermassive black hole. However, ground-based seeing-limited imaging from Rubin will only allow for the centroiding of transients to several tenths of an arc second, which still allows for significant contamination by supernovae. With space-based diffraction-limited near-infrared imaging with Roman, one can centroid transients to an accuracy of milli-arcseconds, greatly increasing the probability that a nuclear transient is powered by the galaxy's central black hole, and enabling the exploration of supermassive black hole accretion activity with no bias introduced by light curve or spectroscopic filtering.

It is feasible for Roman to localize Rubin-discovered transients with only one significant detection of the transient by Roman. A detailed light curve is not required. Thus given the typical duration of normal supernovae and tidal disruption events, Roman monitoring of the Rubin LSST area with a relatively slow cadence of 1 month, in only one filter, would be able to localize them in at least one epoch of Roman observations. Once the transient is localized, the rich multiwavelength information about the host galaxy from joint Rubin and Roman static sky imaging can be used to characterize its environment.

Aaron Meisner

A New Window into the Milky Way's Structure and History

What is the nature of star formation at very low masses?

Modern optical surveys have enabled tomography of the Milky Way using populations such as main sequence turnoff stars. The Milky Way's cold, substellar population also carries a wealth of information about our Galaxy's structure and the star formation process at low masses, but thus far studies of these coolest objects have been limited to the Sun's very local neighborhood. The combination of deep red-optical and near-infrared survey data from Roman and Rubin will vastly expand the volume covered by samples of cold (sub)stellar objects, allowing us to: map the Galaxy's scale height into the L and T spectral classes, understand any metallicity dependence toward the bottom of the substellar mass function, characterize the stellar/substellar boundary's evolution with metallicity, trace low-mass star formation over cosmic time, and probe the age versus temperature relation of brown dwarf cooling.

Sample selection will be a primary challenge in this endeavor. Rubin naturally complements Roman in identifying distant substellar objects, through the extended wavelength coverage it affords into the optical and the lengthened Rubin+Roman time baseline available for proper motions. Tools for joint analysis of Roman+Rubin survey data archives would help enable this science case, particularly cross-matched catalogs, homogenized astrometry, and ideally "forced photometry" of each survey's detections in the other's imaging.

Misty Bentz

The Morphologies and Environments of Galaxies Hosting Changing-Look AGN

What is the physical mechanism behind rapid and large changes in the accretion rates of active galactic nuclei?

Active galactic nuclei that radically change their accretion rates, appearing to either turn "off" or "on", were once a rarity but are becoming more common with the advent of surveys that repeatedly scan the night sky. Currently, there are numerous proposed physical mechanisms to explain how such changes may happen, but not enough observational evidence to definitively constrain them. The moderate spatial resolution and repeated scanning that will be provided by Rubin will uncover a treasure trove of "changing-look" AGN, detected as large and rapid changes in the nuclear flux of spatially-resolved galaxies. Coupled with the diffraction-limited spatial resolution of Roman imaging and the low background provided by space-based observations, the detailed morphologies and environments of the host galaxies of changing-look AGN may be explored in detail down to very low surface brightnesses. Thus, faint signatures of minor mergers and other clues related to a change in nuclear accretion may be discovered, potentially informing our understanding of the mechanism behind the changing-look phenomenon.

Rob Jedicke

Characterizing Extreme Members in Rubin's Solar System Catalogue

What is the composition, physical state, and morphology of the most unusual small bodies discovered by the LSST?

One of the LSST's key science goals is to generate a catalog of the solar system that will contain an order of magnitude more objects than are currently known. Within its vast set of discoveries Rubin is likely to identify extreme objects within and passing through our solar system such as main belt object cratering or disruption events, small objects with outrageous morphologies, near-Earth objects on impact trajectories, interstellar objects, and perhaps even a distant planet in our own solar system. Roman will provide detailed observations of these faint, extreme objects to explore how they fit into the puzzle of our own solar system's formation and the larger picture of all planetary systems. High resolution Roman images of 'active' small objects will determine whether the events are due to thermal spin up, impacts, or other processes. High precision Roman photometry will allow the determination of the shapes of the faintest and most elongated objects in the solar system e.g. to determine whether 1I/Oumuamua's unusual shape remains uncommon when compared to similar-size objects in our solar system. If an object is detected on an Earth-impact trajectory, Roman's faint limiting magnitude and space-based vantage point will provide the necessary astrometry to refine its orbit and impact probability. Finally, the LSST provides the best opportunity in the foreseeable future of detecting a distant planetary-size object in our own solar system. Roman's unique capabilities will be important to revealing its properties and establishing its dynamical and evolutionary trajectory to its current state and location.