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- Planetary Defense – Recent Progress & Plans
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***Invited Talk**

Existing and Expected Near-Earth Object Follow-up Capabilities

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ABSTRACT

NASA's goal to discover at least 90% of all Near-Earth Objects (NEOs) that are 140m in diameter or larger is being addressed by several discovery teams scanning the night sky at every opportunity that observing conditions (i.e., weather and moon phase) will allow. Working in tandem with these survey programs are follow-up telescopes. Follow-up programs provide real-time astrometry and characterization data as objects are discovered. This helps search telescopes focus on discovery instead of self-follow-up, which maximizes their discovery efficiency. The supporting observations acquired by the follow-up systems are vital to ensuring that newly discovered asteroids or comets have well-defined orbits and can be recovered at their next apparition. Further, confirming observations on nights subsequent to discovery supplies the extended arc necessary to establish an orbit with sufficient precision to verify whether or not the object is actually an NEO, and if it is potentially hazardous.

Since for the standard NEO, astrometric follow-up is essential, having a geographically (including each hemisphere) distributed set of dedicated or semi-dedicated observatories is highly advantageous and facilitates continual night-time coverage. There presently exists a robust network of amateur and professional follow-up observers who supply the majority of additional astrometry needed to catalog NEOs. Coordination of effort between such a dispersed association of telescope facilities is proficiently accomplished through the Minor Planet Center's NEO Confirmation Page (NEOCP). Any observing team can access the NEOCP webpage or communicate with other observers through its blog site throughout the observing night. This method of coordination helps avoid duplication of effort and

allows each facility to plan their night's observations with an understanding of what other programs have covered or have been unable to cover due to weather, seeing conditions, technical difficulties, observer availability, or even the limiting magnitude reachable by their particular system. While follow-up of objects to visible magnitude $V \sim 20$ are well supported by the various amateurs and professionals with 1 meter-class or smaller telescopes, follow-up observations of much fainter objects are typically accomplished by facilities with larger aperture telescopes.

A bonus to the astrometry provided by follow-up programs is the acquisition of physical characterization data. Researchers deploying follow-up telescopes have one-of-a-kind, real-time access to the study of unique objects before they leave the near-Earth vicinity. To capitalize on this opportunity, some follow-up programs leverage their observations to obtain characterization data on the most interesting, newly discovered NEOs (including potential spacecraft targets). Time-resolved photometry (i.e., lightcurves) can provide estimates of shapes and spin rates of NEOs, and filter photometry or spectroscopy can yield composition. Physical characterization information such as this is highly beneficial to enhancing our knowledge of the formation and history of our solar system, and contributes to hazard mitigation planning for potential Earth-crossing NEOs.

As the existing discovery systems improve their search strategies and uncover smaller, and smaller objects, and when new larger-aperture systems are added in forthcoming years, the follow-up telescope network will have to optimize their observing approach and instrumentation to keep pace. An overview of current and near-future NEO follow-up capabilities, both amateur and professional, will be presented.