LINNAEUS
Boosting Near Earth Asteroid Characterization Rates

Martin Elvis\textsuperscript{1}, Lin Allen\textsuperscript{2}, Eric Christensen\textsuperscript{3}, Francesca DeMeo\textsuperscript{1}, Ian Evans\textsuperscript{1}, Janet DePonte Evans\textsuperscript{1}, Jose Luis Galache\textsuperscript{1,4}, Nick Konidaris\textsuperscript{1}, Joan Najita\textsuperscript{1, 2}, Tim Sparks\textsuperscript{1, 4}


\textbf{ABSTRACT}

LINNAEUS will:
- Find out How Big
- thousands of NEOs are
- & What They Are Made Of
- by 2018
- for under $1000 each

\textbf{The LINNAEUS Approach}

\textbf{Ground-based Spectroscopy: Optical Wins}

- Optical vs. near-IR Spectroscopy
  - Near-IR: 3m (RTT) vs. NEO will reach V=15.5 m ~45 min
  - Optical: 2.1 m gates to V=22.5 m ~45 min
  - At a mean ~15 speckle, 50% of 2.1 m gives
  - 113 clear nights/year ~1700 speckle/year
  - Keeps up with discovery rate ~ LINNAEUS

- How quick a follow-up?
  - Most NEOs only briefly bright:
    - Few % V=17.5 hr ~6 days
    - 60% V=20.5 hr ~3 days
    - LINNAEUS
  - Can’t wait to do if PHO requires space observing, will permanently reorient spectrograph.

- Immediate Follow-up, not Next Apparition:
  - Most NEOs found within 0.5 mag of brightest
  - Most (much) fainter on next apparition
  - Immediate follow-up strongly preferred

\textbf{LINNAEUS: 3 Elements}

1. 50% of KPNO 2.1 meter
   - Mean observing efficiency 62%
   - 113 clear rights ~1700 speckle/year
   - ~5000 NEO spectra in 3.5 years
   - Can track best NEOs
   - Average seeing 1.5 ~ 1.8 arcsec

2. Integral Field Unit (IFU) spectrometer
   - Copy of working Panemer 1.5m (PES) at KPNO (PI: Nick Konidaris)
   - High throughput
   - R=150
   - Spectral imaging of failed for accurate spectro-photometric calibration (~2%)
   - 1-2 min observation
   - Spectrally resolved direct v
   - Limited #
   - No need for accurate spectrometers
   - Stable instrument
   - Parallactic angle not needed

3. Rapid Response, Release of Results
   - Robust pipelines, archive
   - worked or UK, written, managed for her use
   - Scope MPEC data pages continually
   - Produce by 1/2 day prediction, proofs, orbits.
   - Receive data, process and release taxonomy to MPC within 2 hours
   - Archive of original data and results
   - Inaccurate archive via MPC, PDS

\textbf{LINNAEUS: a 5-year Program}

- 1.5 years to build, test SED-M
- 3.5 years of operation
- ~5000 NEO spectra
- Cost: ~$800/NEO spectrum
- Includes Research: 1 student and 2 postdocs
- to work on spectra, refine taxonomy, sizes, correlated observations (e.g. NEOWISE)
- Δcost for 100% of KP2.1m: $753k: $150/extra NEO spectrum

\textbf{LINNAEUS: A 5-year Program}

- 1.5 years to build, test SED-M
- 3.5 years of operation
- ~5000 NEO spectra
- Cost: ~$800/NEO spectrum
- Includes Research: 1 student and 2 postdocs
- to work on spectra, refine taxonomy, sizes, correlated observations (e.g. NEOWISE)
- Δcost for 100% of KP2.1m: $753k: $150/extra NEO spectrum

\textbf{Carolus Linnaeus (1707 – 1778)}

Was the botanist and zoologist who classified all living species then known: 4952 animal and 7700 plant species.

- We aim to classify a comparable number of NEOs