**EXCEDE: The Exoplanetary Circumstellar Environments And Disk Explorer**

Utilizing A Phase Induced Amplitude Apodized Coronagraphic Telescope For High Contrast Imaging Of Circumstellar Planet-forming Environments

Glenn Schneider and the EXCEDE Science and Mission Team

**Science Objectives**

**Discovery Science**
- Obtain a compendium of scattered light images of solar systems in formation
- Probe dust-scattered starlight within the inner (terrestrial) habitable zones of exoplanetary systems
- Reveal the presence of previously undetected planets by measuring asymmetries in disk structures

**Characterization Science**
- Directly image Jupiter-like planets in nearby exoplanetary systems
- Determine physical and geometrical properties of dust grains within circumstellar environments over a range of stellar ages
- Assess the growth of protostellar dust grains into planets/stars by comparing dust properties of young planet-forming CS environments over the epoch of planet formation

**Relevance to NASA Science Programs**
- Strategic Plan subgoal 3b: "conducted advanced telecopic searches for Earth-like planets and habitable environments around other stars"
- Science Plan - Strategic Goals and Decadal Outcomes: "understand...the formation of...planetary systems...and...what properties of a star...are most strongly correlated with the presence of habitable Earth-like planets"

**Mission Objectives**
- 50 cm diameter unobscured aperture off-axis telescope
- Passive optic for wavefront error correction
- Phase Induced Amplitude Apodized Coronagraph
- 1 J/D image plane masks
- Two-band polarimetric imager

**Science Payload**

**Instrument Characteristics**
- Spectral bandwidth: 0.4 - 0.8 μm (20% FWHM)
- Coronagraph inner working angle: 0.2" at 0.4 μm, ~0.8 μm
- Raw unapodized IA image contrast: point-source: 10", azimuthal median: 10" (self-screening)
- Spatial resolution: 200 mas at 0.4μm
- Linear Polarimetry with Wolfson arrays
- Coronagraphic Polarmetry IWA contrast: down to 10^-4 for strongly polarizing dust around bright unpolarized stars
- Full Polarimetric Field of View: 40" x 40"
- Image scale: 83 mas/pixel (PSF-critically sampled at 0.4 μm)
- Image data format: 2 x (512 x 512) pixels
- Science detector: low noise, high QE, high dynamic range CCD
- Guiding array: low noise CCD to produce target derived optical FES with NEA < 2 mas to PCS

**Mission Objectives**
- Type: Small Explorer/Astrophysics
- Launch Vehicle: Pegasus XL
- Launch Date: unannounced > January 2012
- Orbit: Sun-Su, semi-major axis: 3000 km
- e=0.1, i=99°, LEO
- Duration: 2 years after IOC + 1 yr SEOs

**EXCEDE TELESCOPE & INSTRUMENT**

**PIAAC, RELAY, and CAMERA OPTICS**

**SPECTRAL ELEMENTS**

**SCIENCE CAMERA**

**WAVEFRONT CONTROL & CONTRAST**

**LOW ORDER WAVEFRONT SENSOR (LWFS)**

**Considerations:**
- The high density and large scale of the LWFS is essential for controlling optical path differences (OPDs) to less than 100 nanometers. The LWFS must observe the target and the reference arms simultaneously to detect OPDs. The LWFS mirror is approximately 50 cm, tilted by 30°, and has a common focal plane with the primary mirrors. The primary mirror on the LWFS is rigidly mounted on an advanced lightweight carbon composite structure. The LWFS data is processed by the LWFS control computer, which executes a calculated control algorithm to reduce the OPDs. The LWFS data is then fed to the primary mirror control computer, which uses this information to correct the OPDs.