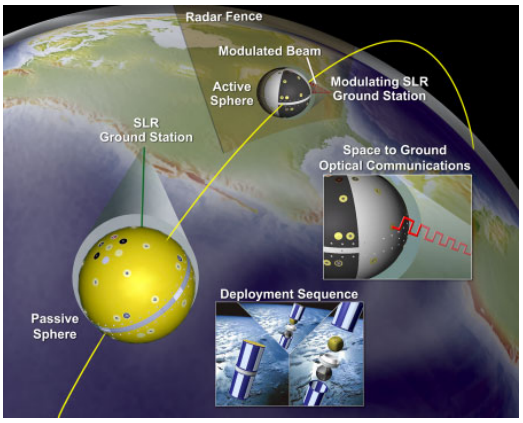
# Atmospheric Neutral Density Experiment (ANDE)

ANDE is a low cost mission under development at the Naval Research Laboratory (NRL) to demonstrate a method to monitor the thermospheric neutral density at an altitude of 400 km. The primary mission objective is to provide total neutral density along the orbit for improved orbit determination of resident space objects. The mission serves as a test platform for a new space to ground optical communications system, the Modulating Retro-reflector Array in Space (MODRAS).

The mission consists of two spherical spacecraft fitted with retro-reflectors for Satellite Laser Ranging (SLR). One spacecraft is completely passive, the other carries three active instruments; a miniature Wind And Temperature Spectrometer (WATS) to measure atmospheric composition, cross-track winds and neutral temperature; a Global Positioning Sensor (GPS); and a Thermal Monitoring System (TMS) to monitor the temperature of the sphere. A design requirement of the active satellite is to telemeter the data to the ground without external protrusions from the spherical spacecraft (i.e. an antenna). The active satellite will be fitted with the NRL-developed MODRAS system, which is a science enabling technology for the ANDE mission. The MODRAS system consists of a set of modulating retro-reflectors coupled with an electronics package, which will telemeter data to the ground by modulating and reflecting the SLR laser interrogation beam.

The concept of the ANDE mission is to build and fly two satellites in a lead-trail 400 km circular orbit . The US Space Surveillance Network (SSN) as well as domestic and international satellite laser ranging (SLR) sites will make routine observations of the satellites. The satellites will consist of two spheres constructed to the same dimensions but from different surface materials. The satellites will have a known mass ratio (2:1) and a mission lifetime of 1-3 years depending on solar activity. In orbit, the satellites will slowly separate from each other due to the difference in mass. Precise monitoring of the satellites' position with SLR will provide an opportunity to study small scale, spatial and temporal variations in drag associated with geomagnetic activity.




ANDE is a low cost constellation of micro satellites designed to support improvements in orbit determination and prediction. The arrangement of two spacecraft in a lead-trail orbit with identical cross-sectional areas provides an exceptional set of targets to study $C_D$ modeling and its effect on satellite drag. The active satellite contains instrumentation to test the feasibility of an optical communications link from space to ground. The data retrieved from the active satellite will be used to validate UV derived densities from the DMSP satellite. This mission will demonstrate the effectiveness of flying low cost calibration targets to support Department of Defense and NASA requirements for precision orbit determination and collision avoidance. In addition, data from this mission will be used to improve the scientific understanding of the interaction between a spacecraft and its environment.

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