Vesper – Venus Chemistry and Dynamics Orbiter - A NASA Discovery Mission Proposal: Submillimeter Investigation of Atmospheric Chemistry and Dynamics

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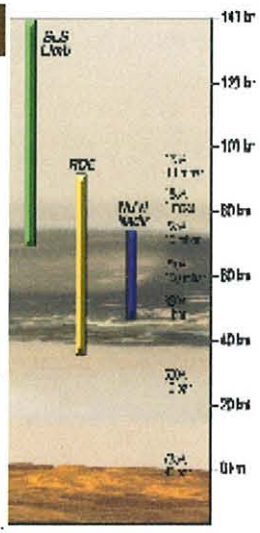
Why Venus—Why Vesper

Vesper conducts a focused investigation of the chemistry and dynamics of the middle atmosphere of our sister planet— from the base of the global cloud cover to the lower thermosphere. The middle atmosphere controls the stability of the Venus climate system. Vesper determines what processes maintain the atmospheric chemical stability, cause observed variability of chemical composition, control the escape of water, and drive the extreme super-rotation.

The Vesper science investigation provides a unique perspective on the Earth environment due to the similarities in the middle atmosphere processes of both Venus and the Earth. Under- standing key distinctions and similarities between Venus and Earth will increase our knowledge of how terrestrial planets evolve along different paths from nearly identical initial conditions.

Instrumentation	Science Drivers
Submillimeter Line Spectrometer (SLS)	• Direct Winds • Temperatures • Abundance Sensitivity • Extensive vertical coverage at scale height resolution
Near Ultraviolet and Infrared Imager (NUVI)	• Cloud level winds • Cloud level H_2O
Radio Occultation Experiment (ROE)	• High level resolution profile density with derived temperature/ pressure



In a polar circular orbit, the Vesper science instruments— Submillimeter Line Spectrometer (SLS) and Near Ultraviolet and Infrared Imager (NUVI), and the Radio Occultation Experiment (ROE)— provide a global, vertical, and local time distribution of major and minor chemical constituents, temperature, and direct measurements of wind. A science mission duration of two Venus years offers the opportunity to characterize variability of atmospheric phenomena.

The main science instrument on Vesper is the Submillimeter Line Spectrometer (SLS). The SLS combines a 50 cm aperture, spaccraft fixed telescope with a dual-band, tunable, high spectral resolution, spectroscopic receiver using proven space-qualified technologies.

SLS derives its heritage from a number of flight instruments. Space flight Schottky diode- based submillimeter radiometers include the UARS MLS, EOS Aura MLS, SWAS, MIRO/Rosetta, and Odin. SLS also derives its heritage from the HIFI instrument on the Herschel Space Observatory launched successfully in 2009. A 4096-channel Chirp Transform Spectrometer (CTS) is currently flying on MIRO/Rosetta.

SLS consists of a 50 cm (projected) offset parabolic reflector telescope followed by two submillimeter heterodyne receivers. Center-band operating frequencies are 470 GHz (Band 1) and 560 GHz (Band 2). Each receiver includes a very high resolution $1/dl > 1x10^6$) CTS having a 400 MHz instantaneous bandwidth and 4096 channels. Individual channel bandwidths are ~100 kHz. Both receivers can be tuned over ±30 GHz, permitting spectral line observations anywhere within 440–500 GHz (0.60–0.68 mm) in Band 1 and 530–590 GHz (0.51–0.57 mm) in Band 2. The two bands include all trace gases known to be present in the Venus upper atmosphere as well as several undetected species.

The figure below shows a depiction of the SLS instrument with its 50-cm off-axis Cassegrain telescope and receiver and electronics components.