**CUVE – Cubesat UV Experiment**

Unveil Venus’ UV Absorber with CubeSat UV Mapping Spectrometer

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**CUVE TEAM includes experts in:** Venus’ atmospheric composition, chemistry, dynamics and radiative transfer; Mission and Instrument Design; Venus mission concept formulation studies; Design, fabrication and operation of spectrometers for remote sensing

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**WHY VENUS?**

Venus is an ideal target for SmallSats deep space exploration:
- Reachable by an independent small spacecraft
- ~1/3 of low-mass stars have planets in the Venus-zone (interior to HZ)
- Still open compelling questions that needs to be addressed
- UV measurements must be acquired from space
- Venus science achievable with cost efficient compact spacecraft
- Public is very interested in Venus exploration (CUVE > 70 articles in few months from more than 10 countries)

**PREVIOUS UV OBSERVATIONS**

- **Pioneer Venus**
  - CUVE
  - VIRTIS (M Visible)
  - 290-1100 nm
  - 2 nm

- **Venus Express**
  - SPICAV (SUV)
  - 110-310 nm
  - 1.1.5 nm

- **Venus Express**
  - VMC (UV)
  - 345-384 nm
  - 40 nm

- **Akatsuki**
  - UV
  - 293-365 nm
  - 72 nm

- **HST**
  - STIS (low/mod Res)
  - 115-555 nm
  - 0.27 nm

- **Messenger**
  - MASCIS VIS
  - 300-1000 nm
  - 4.7 nm

- **CUVE**
  - Spectrometer
  - 200-400 nm
  - 0.2 nm

- **CUVE**
  - Imager
  - 320-570 nm
  - 4 nm

- **CUVE**
  - Bands not resolved in VIRTIS and SPICAV spectrometers

**CUVE can provide high resolution UV spectrum of Venus, with large coverage and imaging of cloud top structure to derive the science objectives:**
- 1. Nature of the UV-absorbers;
- 2. Abundances and distributions of SO$_2$ and SO at and above Venus’s cloud tops and correlation with the UV absorber;
- 3. Atmospheric dynamics at the cloud tops, structure of upper clouds and wind measurements from cloud-tracking

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**VENUS CLOUD TOP SCIENCE**

- Venus clouds reflect in the visible most of the incoming solar radiation (albedo ~75–90%)
- ~50% of the solar energy received by Venus is absorbed in the UV by a unidentified absorber in its top cloud layer
- This absorbed energy is the primary atmospheric engine of Venus
- Clouds top structure and UV absorbers nature are key parameters for understanding Venus’ atmospheric dynamics and energy balance
- Venus science is achievable with cost efficient compact spacecraft
- Public is very interested on Venus (> 70 articles on CUVE in few months from more than 10 countries in the world) – see bottom page – and see Jessup, K.-L. et al. Motivations for a Detailed In-Situ Investigation of Venus’ UV Absorber. VEXAG 2017 - LPI contribution and EPSC 2018.

**CUVE – Cubesat UV Experiment – on a polar orbit around Venus**

- **Data Telemetry**
- **Nadir Observation**

**CUVE Payload**
- UV image spectrometer
  - 200 – 400 nm
  - 0.2 nm spectral resolution
- UV multispectral imager
  - 320 – 570 nm
- **CUVE UV absorber nature**
- **CUVE UV absorber distribution and atmospheric dynamics**

**MISSION OVERVIEW**

- 1 unique 12U spacecraft
- Can be deployed from Geostationary Transfer Orbit (GTO)
- Other possible rideshare opportunities: LEO missions, Heliophysics, Discovery, New Frontiers
- Spacecraft reach Venus using internal electrical propulsion system
- At Venus, spacecraft will be placed in high altitude polar orbit
- Spacecraft establishes direct communication with DSN during cruise, instrument check-out, insertion, operations
- Mature TRL: Most component have high TRL (6-8).
- Mission end: orbital decay into Venus (no planetary protection concerns)

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**KNOWN AND POTENTIAL UV ABSORBERS**

Known absorbers:
- SO$_2$, varies from 0.1 to 1 ppm at the cloud top (Barker 1979, Conway et al. 1979, Stewart et al. 1979, Esposito et al. 1988, Bertaux et al. 1996 Markq et al. 2011)
- SO about 30% of SO$_2$ (Na et al., 1990)

Other candidate species for the observed UV contrast features:
- Sulfur-bearing species - sulfur S$_2$, S$_3$, S$_4$, OSSO – FeCl$_2$
- Zasova 1981 proposes 1 % FeCl$_2$ in 80% H$_2$SO$_4$ and Krasnopolsky (1986) favored it

**CUVE SIMULATED DATA**

Nadir UV dayside spectrum is mostly composed of solar light back-scattered by atmospheric cloud particles.

- From the spectrum we can derive information about scattering particles and gases encountered in the atmosphere by the scattered solar radiation.
- Inhomogeneity in spatial/vertical distribution of the unknown absorber produces the famous UV features – used also to study the dynamics of the clouds.

**Venus UV spectrum**

CUVE UV spectrum has multiple absorption features between 200 and 500 nm

CUVE lower res multispectral image (320 – 570 nm in blue)

Unidentified absorber above 320 nm

CUVE high res multispectral image (200 – 400 nm) in red

SO$_2$ and also SO bands between 200 and 400 nm