Printed Optical Particle Spectrometer

A small, sensitive, light-weight, and disposable aerosol spectrometer for balloon and UAV applications

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Motivation

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Why aerosols

⇒ large uncertainty about effect on radiative forcing

Scientific questions that are difficult to address with existing tools

- Aerosol profiles inside the Asian Monsoon ⇒ no aircraft excess
- Fire plume sampling ⇒ no aircraft excess
- Volcanic aerosol and ash quantification ⇒ no aircraft excess, monitoring needed
- Geo-engineering ⇒ monitoring needed

⇒ A small, light-weight, low cost, low power optical particle counter will help greatly

IPCC: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis
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⇒ **Printed Optical Particle Spectrometer**
How POPS works

- **Light-source**: 405 nm laser diode
- **Beam shaping**: aspherical, and cylindrical lenses shape laser to line
- **Light collection**: spherical mirror image scattered light on **Photomultiplier Tube**
- **Stray light**: multiple slits suppress stray light
- **Signal processing**: PMT output current converted to voltage → amplified → digitized (4 MHz; 16 bit) → analyzed on single-board computer → communicate via serial port
- **Sizing**: intensity of scattered light depends on particle size

R. S. Gao et al., *Aerosol Sci. Technol.* 2013, 47, 137
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**Mie scattering simulation**

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POPS versus UHSAS

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Dimensions:
- 15x6x6 cm
- weight < 1 kg
- cost* ~2500 $
- power 3 W

* labor excluded

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field test on Manta UAV

package
- POPS
- Condensation Nuclei Counter
- 3 wavelengths aerosol absorption photometer → like CLAP
- aerosol filter sampler → 6 filters
- Radiometer

outcome
- POPS functional
  but interference with UAV communication and other instruments → bursts of noise
  ⇒ improve shielding
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poster by D. Murphy presented by R.S. Gao
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Printed Optical Particle Spectrometer

- **light weight**: < 1 kg ⇒ light enough for small weather balloon or UAV
- **low cost**: ~2500 $ ⇒ disposable
- **diameter range**: 150 - 2500 nm
- **tested**: Manta UAV

POPS will be fully functional in a couple of months!
acknowledgment

- Ru-Shan Gao
- Laurel Watts
- Steven Ciciora
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