LONSCAPE: Light Optical Nephelometer Sizer and Counter for Aerosols in Planetary Environments



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We propose two improvements to the design of the LONSCAPE instrument, a nephelometer and particle counter for planetary exploration. First, we look at lowering the wavelength of operation to 400nm, reducing the minimum particle size detectable by the instrument to $\sim 1\mu$ m. Second, we experiment with changing the beam shape to achieve both a larger coverage of the inlet while minimizing the beam crossing time by the particles. This change allows the counting of more numerous particles found in the newly reached size range of the instrument. We find both of these improvements are possible without any major changes to the original design; be it from the measurement of scattered light, operation power, size, or mass.

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Introduction

The LONSCAPE - Light Optical Nephelometer Sizer and Counter for Aerosols in Planetary Environments (Renard et al., 2020) - is a proposed concept combining a particle counter with a nephelometer at several phase angles to characterize the scattering function and obtain precise aerosol properties.

Currently, LONSCAPE is under consideration for multiple missions; one in the atmosphere of Venus (Baines et al., 2021), one on Saturn and one on an ice giant. (Mousis et al., 2016, 2018)



In its current form, the instrument presents many advantages, such as low mass and size, minute power consumption, and a very simple and robust design.

To enhance detection capabilities compared to other instruments, two major improvements have been studied:

- 1. Shifting the wavelength of operation to the blue (650 \rightarrow 400nm)
- 2. Modifying the beam shape to increase particle detection chances while lowering beam crossing time

Numerical simulations

Investigating the quantum efficiency loss of the Si detectors in the blue, and the gains from the d/λ ratio from Mie theory.

We losses find that lower at wavelengths are greatly compensated in theory.

We ran Mie scattering simulations on an in-house model for particles between 0.1 and 10µm, multiple materials (with variable n, k indexes) and various wavelengths.

 \rightarrow Lead to more flux in the detector than in the red





Laser and beam manipulation

A wide panel of lasers was tested for their ease of integration and beam quality. Our goal was to reach a beam thickness of less than 0.25mm (crossing time minimization) for a width of at least 4.5mm (inlet aperture coverage).

A 405nm, 20mW laser was retained; along with a powell lens with a 5° fanning angle.

Testing on the beam shape across multiple unit of the same laser show reproducibility is achievable.



Conclusions

We conducted Mie scattering simulations, and laboratory measurements to estimate the feasibility of changing the operation wavelength of the LONSCAPE instrument. We find that such a change is possible, lowering the operation wavelength to 405nm, easing access to smaller aerosols than previously possible.

Additionally, changing the beam shape is a good solution to accommodate the more numerous particles in this size regime, as well as maximizing their detection in the chamber. Because the atmospheres of the candidates planets are not necessarily well constrained; these changes bring in crucial improvements to establish their properties and compositions.

References

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