

UV Ellipsometry to Measure the Spectropolarimetric Signal of Chiral Amino Acids Abundant in Space Ices

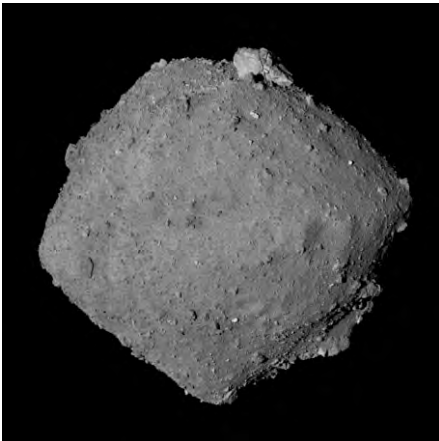
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The Challenge – Can enantiomeric imbalance on minor bodies be detected remotely?

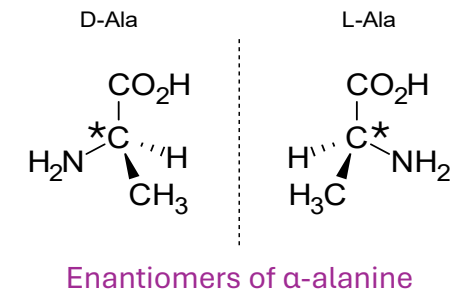
- All known life forms only use L-amino acids as building blocks of proteins.
- The origin of this preferential handedness is unknown.



162173 Ryugu

Image taken from:

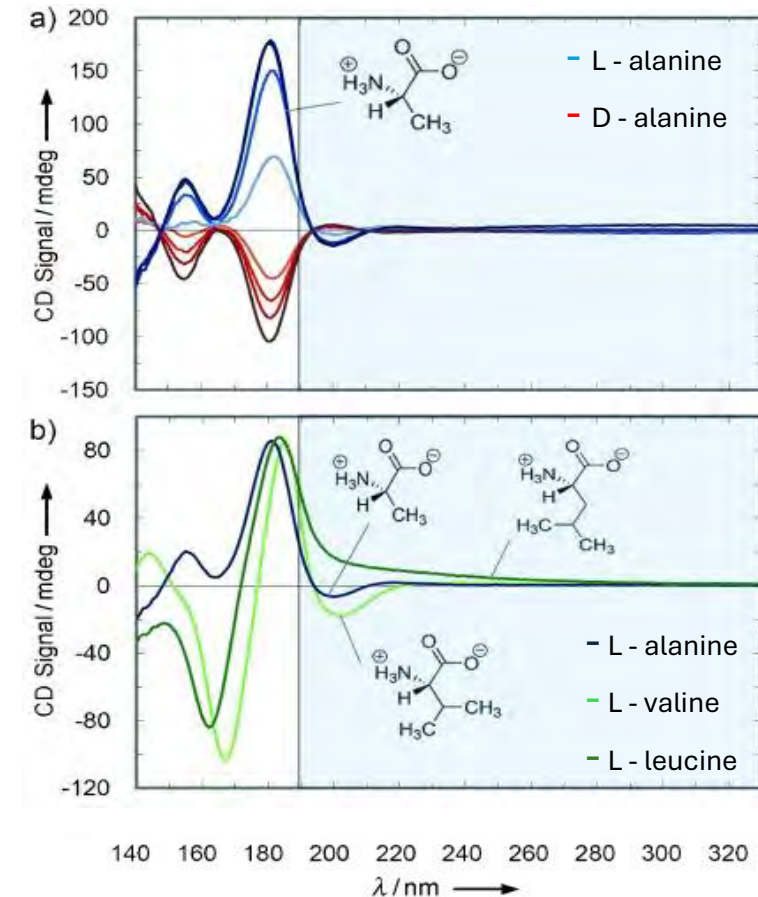
https://commons.wikimedia.org/wiki/File:162173_Ryugu_brightened.png



- Small excess of L-amino acids found in some meteorite - Murchison (Cronin & Pizzarello 1997)
- Amino acids in minor bodies detected via:
 - In situ measurements - comet 67P/Churyumov–Gerasimenko (Altwegg et al. 2016)
 - Returned samples - asteroid Ryugu (Parker et al. 2023)
- High mission costs and potential sample contamination.

The Proposed Solution

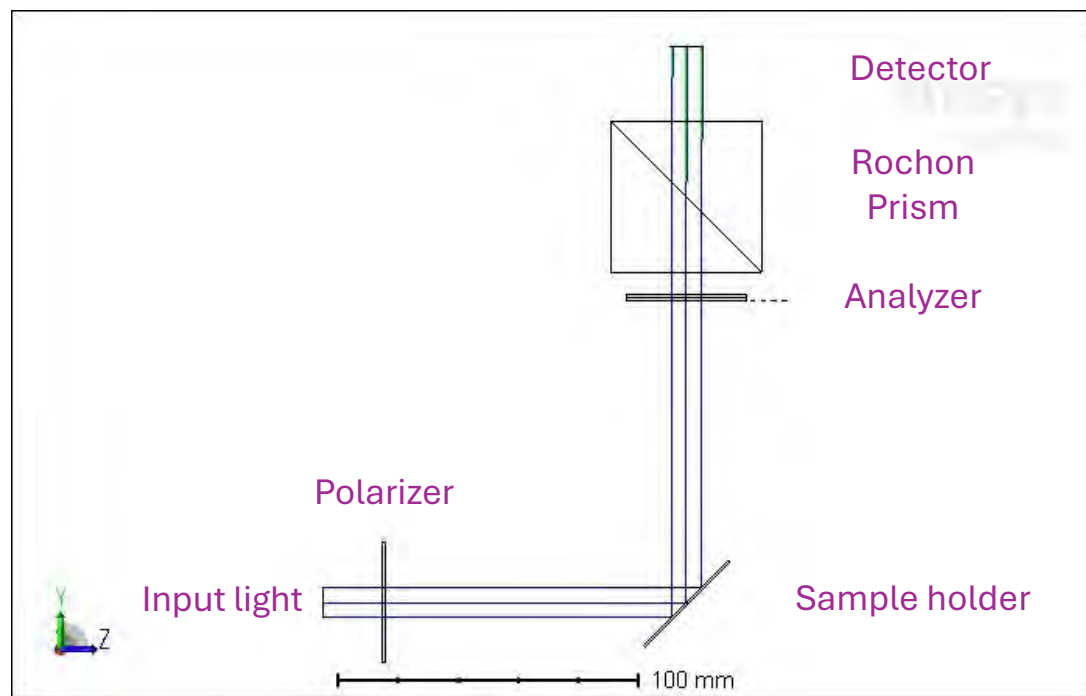
- In VUV, amino acids show strong circular dichroism around this regime, e.g. around 180 nm for alanine (Meierhenrich et al. 2010).
- The aim is to build a spectropolarimeter and test it in the laboratory to measure the ORD signals of amino acids and to see whether the instrument can resolve the L–D difference in circular dichroism signals at levels relevant for observation.
- Once successful, derive requirements for space mission.



CD spectra between 140 and 330 nm of various isotropic amorphous amino acids

Image taken from: Meierhenrich et al. 2010

Experimental Setup and Simulation



Experimental Setup

- Spectral range covered – 140-240 nm.
- Placed under vacuum $\sim 10^{-4}$ mbar.
- The instrument is in its final stages of design.

- The simulation models the whole optical chain for a known input Stokes vector and a known sample Mueller matrix.
- Calculating the Mueller matrix for Alanine and other amino acids.
- DFT calculated complex refractive index data for Alanine - (Caetano et al. 2024)