XCOV31: Multi-wavelength observations of G29-38

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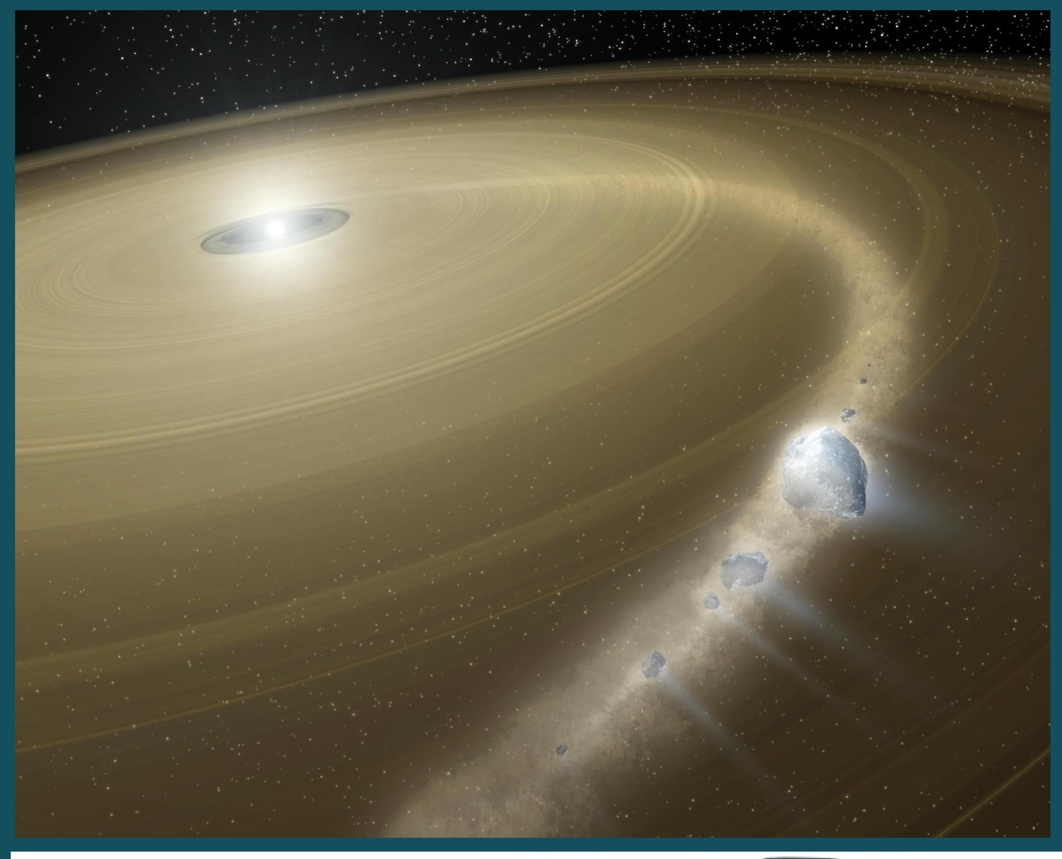
Background:

White dwarf stars are the cores of dead main sequence stars. The outer layers of the star have been blown off, meaning that the core can no longer sustain fusion, and is slowly cooling for the rest of its life. G29-38 is an extremely special white dwarf. Not only does this star pulsate, it also has a surrounding debris disk which has been observed reprocessing the pulsations. G29-38 was one of the first white dwarfs known to have a debris disk.

Observations:

The goal of this project was to use the optical pulsations as a probe of the debris disk. This required that the optical and infrared observations were gathered concurrently, as G29-38's pulsation distribution is known to change on the order of weeks/months. In total, 44 telescopes across the whole world were apart of this Whole Earth Telescope (WET) campaign XCOV31. This project required telescopes across the world to limit the data gaps caused by Earth's day-night cycle. Over 100 people have been involved in this project.

The figure on the right shows the periodogram of the visible light curve of G29-38's XCOV31. The data spans ~26.5 days. Over 101 individual frequencies were identified in this light curve.



An artist's impression of what G29-38 may look like. Image Credit: NASA/JPL-Caltech

Methods:

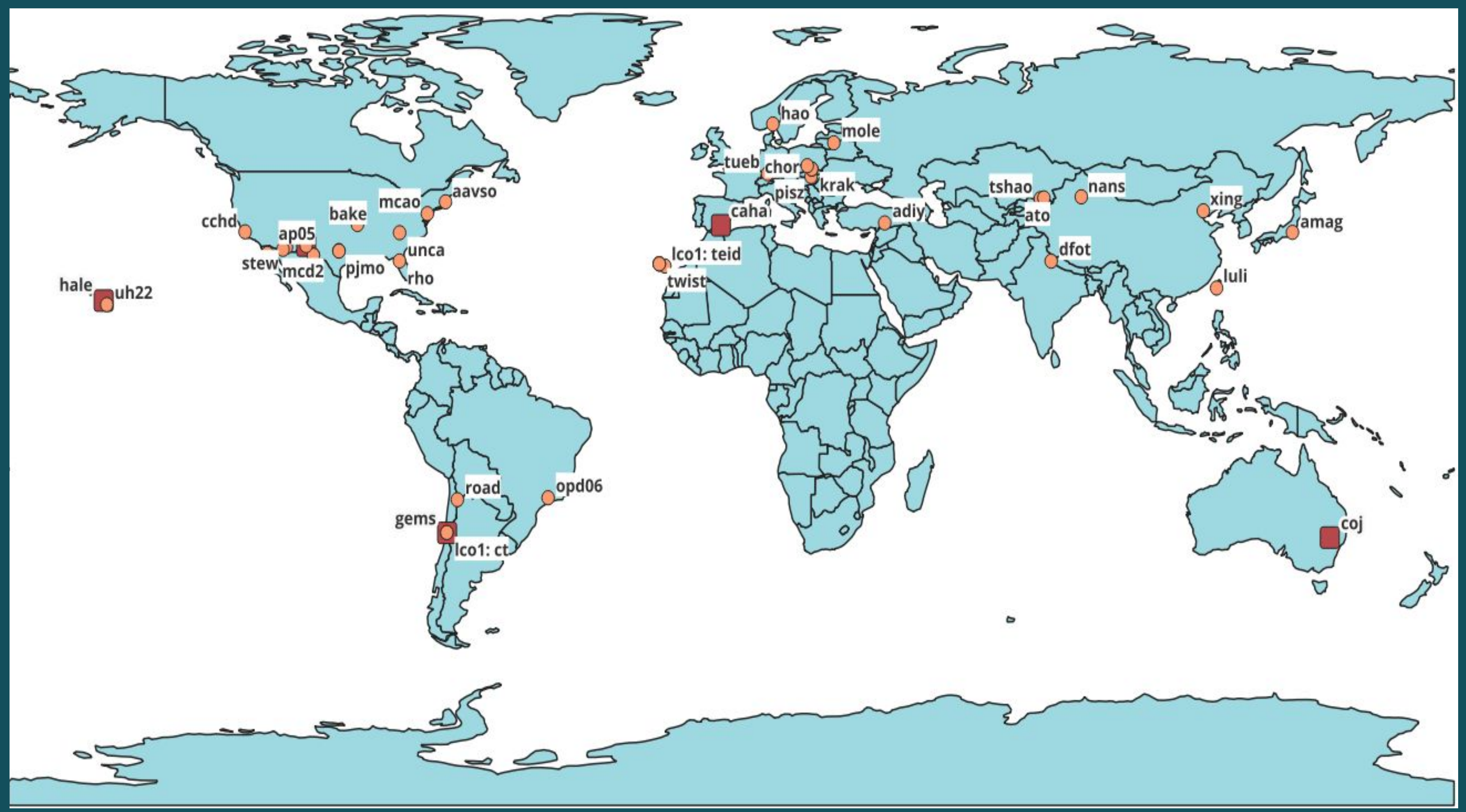
The observations gathered during XCOV31 were reduced using Maestro (Dalessio 2010) and the python package *phot2lc* (Vanderbosch et al. 2026). Once the data from each night of observation was reduced, the *phot2lc* was used to combine these singles night into one visible light curve covering the full campaign baseline. The *Pyriod* (Bell 2022) python package was used to identify the frequencies present in the periodogram of this complete visible light curve.

Secondary Target Selection:

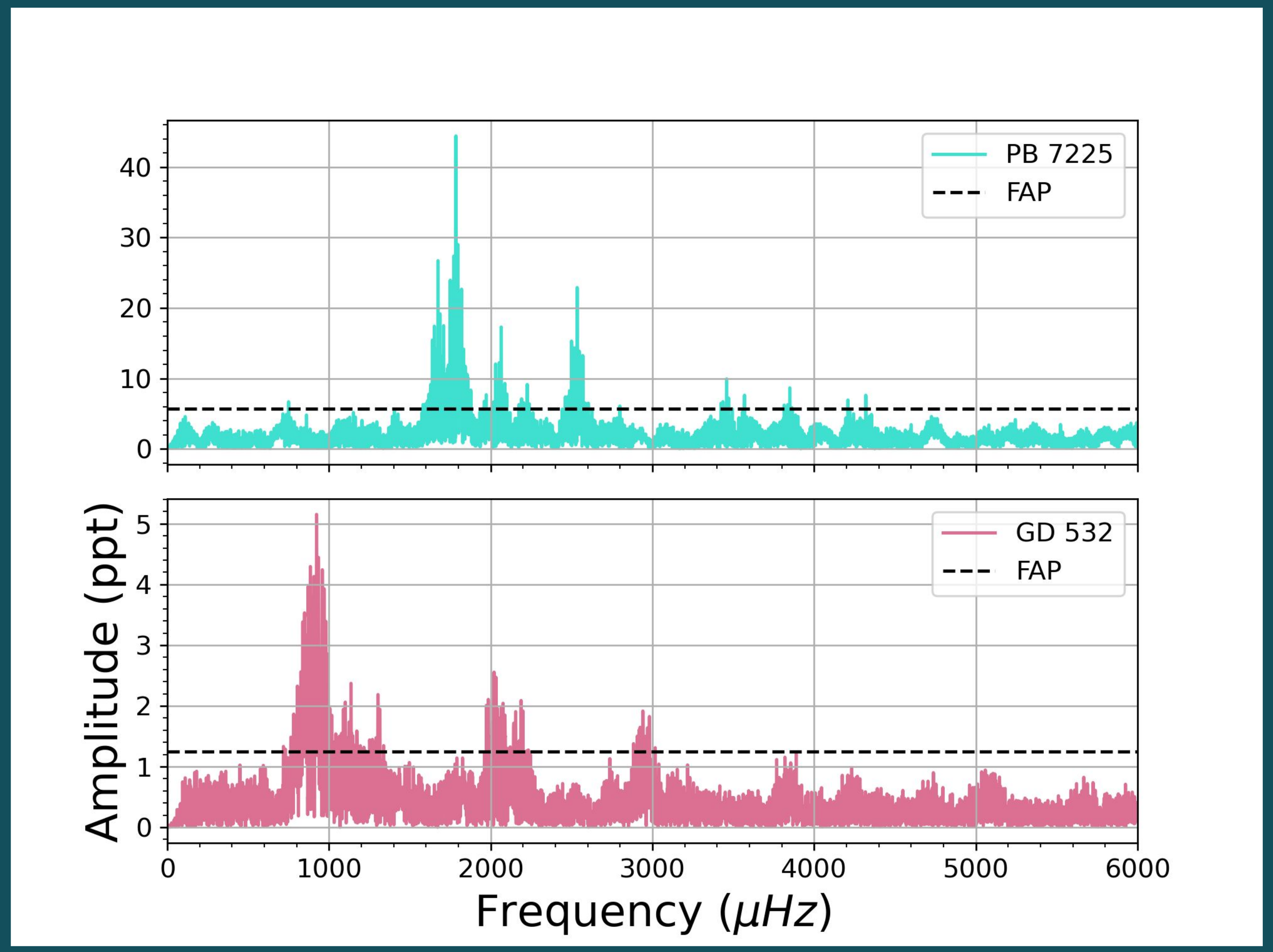
Due to the amount of telescope time received for this project, several secondary targets were observed in addition to G29-38 to minimize overlapping with multiple telescopes.

Two previously known DAVs (GD 532 and PB 7225) were observed to get an updated pulsation distribution. Three DAs (WD 0145+234, Galex J215503.0+761009, and WG 14) were observed to place an amplitude limit on any possible pulsations. All five of these DAs were chosen due to having debris disks.

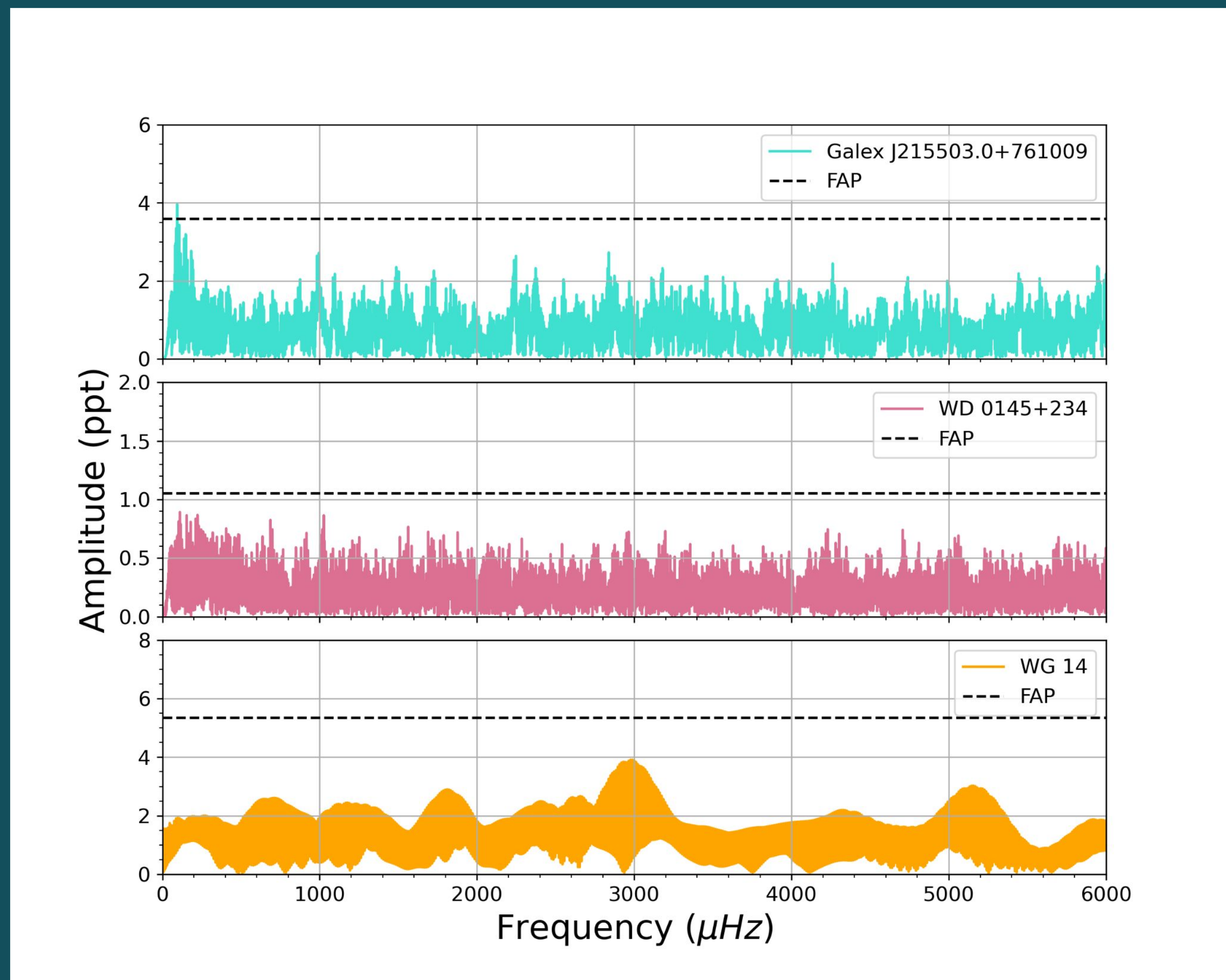
Two known DBVs (PG 0112+104 and KUV 05134+2605) were also observed to try and update their pulsation distributions. The last target ZTF J0328-1219 was observed in conjunction with Hubble photometry.



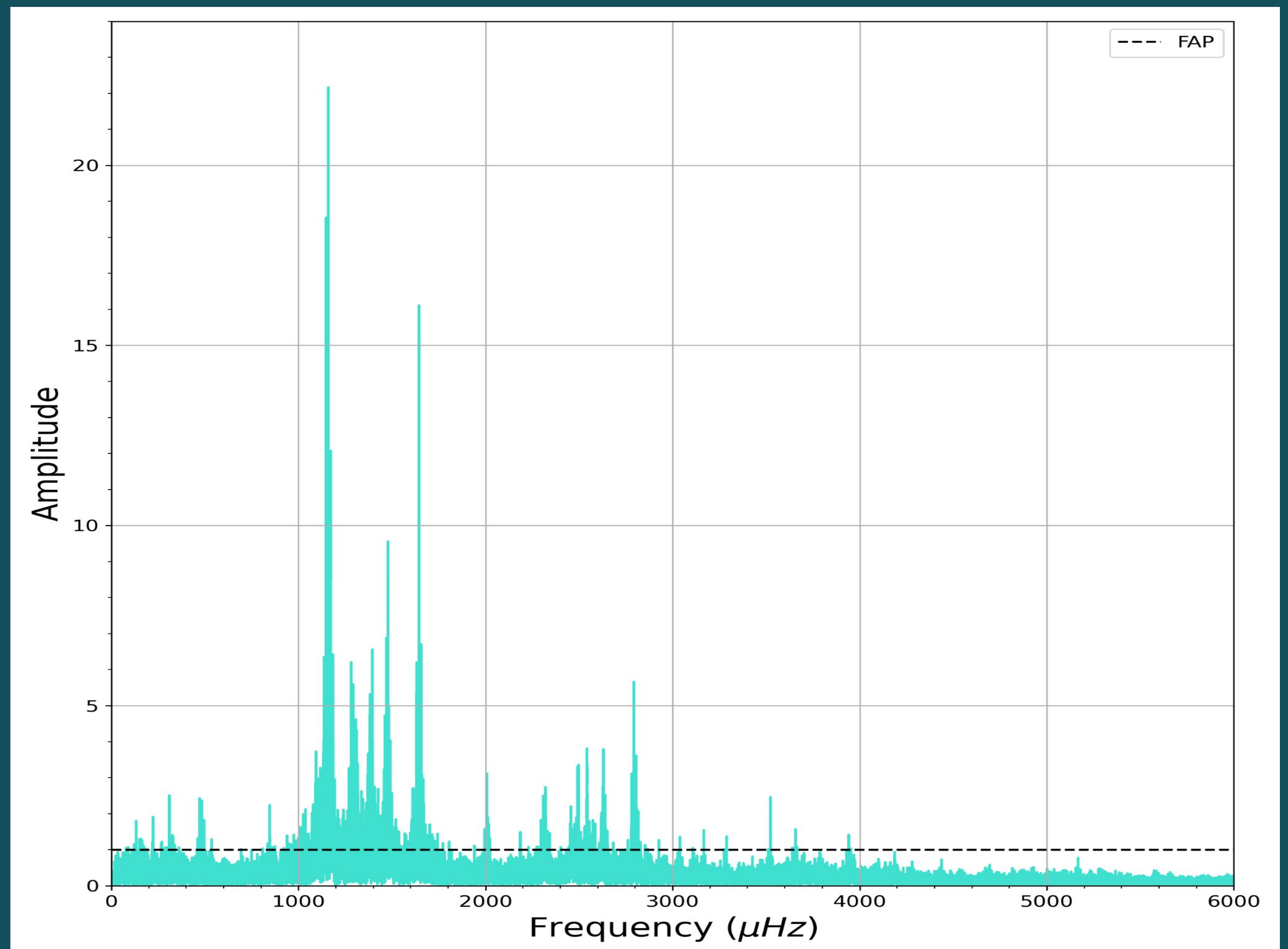
This map shows the distribution of telescopes that participated in XCOV31. They are concentrated in the Northern Hemisphere partially due to G29-38's declination on the sky, and influenced by where telescopes have been built. The light pink circles represent optical telescopes and the darker squares represent the infrared telescopes.

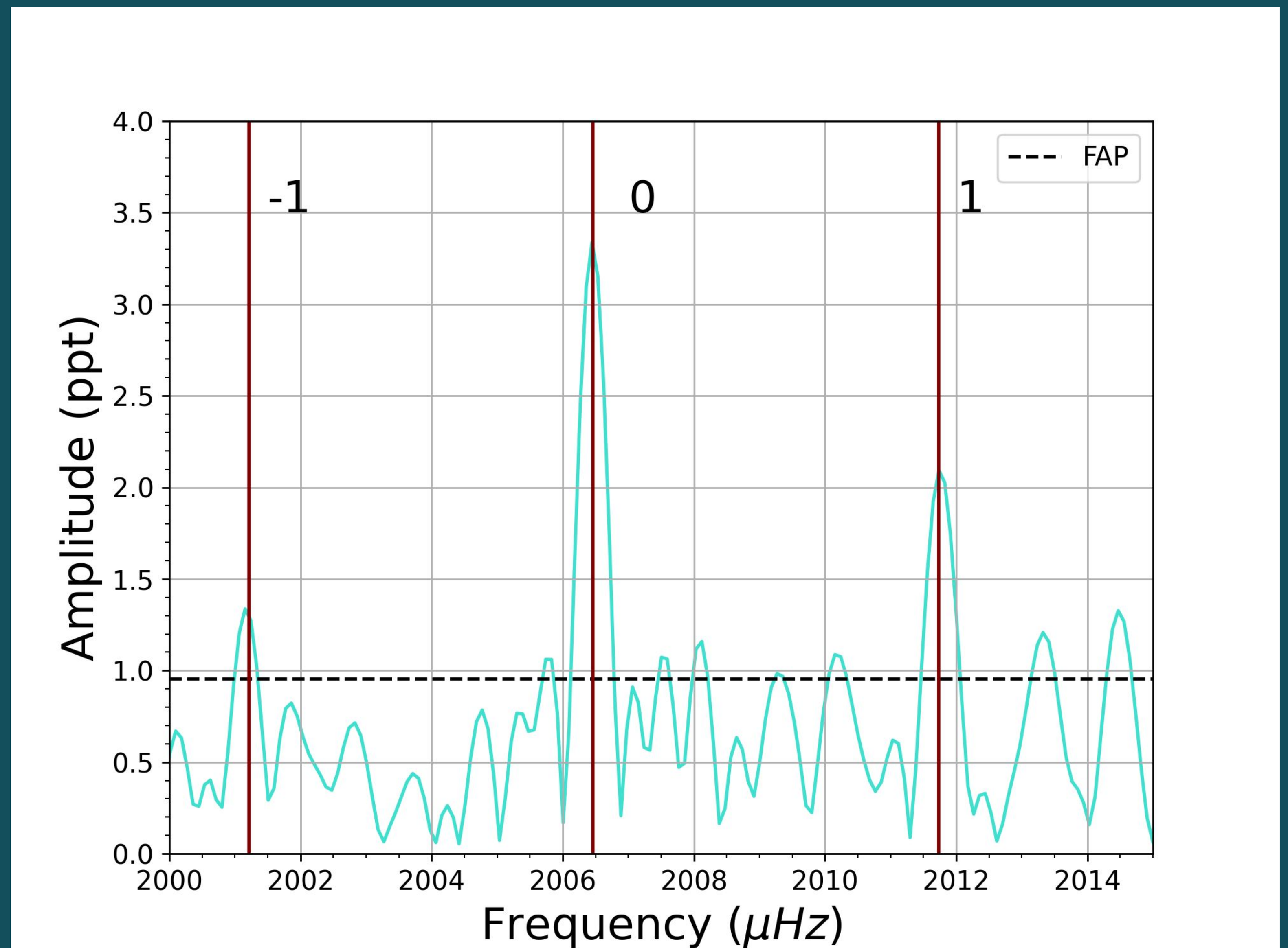


This figure show the periodogram of the two known DAVs that were observed during XCOV31. Eleven frequencies were identified in PB 7225's light curve, and ten frequencies were found in GD 532's light curve.



The plot above shows the light curves of three white dwarfs observed to see if they are pulsating. Only Galex J215503.0 has a frequency above the calculated false alarm probability (FAP).





The figure to the left show an example frequency triplet from G29-38's light curve. The splitting between the members of the multiplet (labeled -1, 0, and 1) is tied to the rotation rate of the white dwarf. This difference can also be used to identify the ℓ of multiplet.

References:

Bell, K. J. 2022, Pyriod: Period Detection and fitting routines. https://ascl.net/2207.007

Dalessio, J. 2010, in American Astronomical Society Meeting Abstracts, Vol. 215, American Astronomical Society Meeting Abstracts #215, 452.09

Vanderbosch, Z. et al. 2026, phot2lc, 1.9.1 Zenado, doi: 10.5281/zenado.5796619

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