

# Insights on the flare stability of G009.62+0.20E

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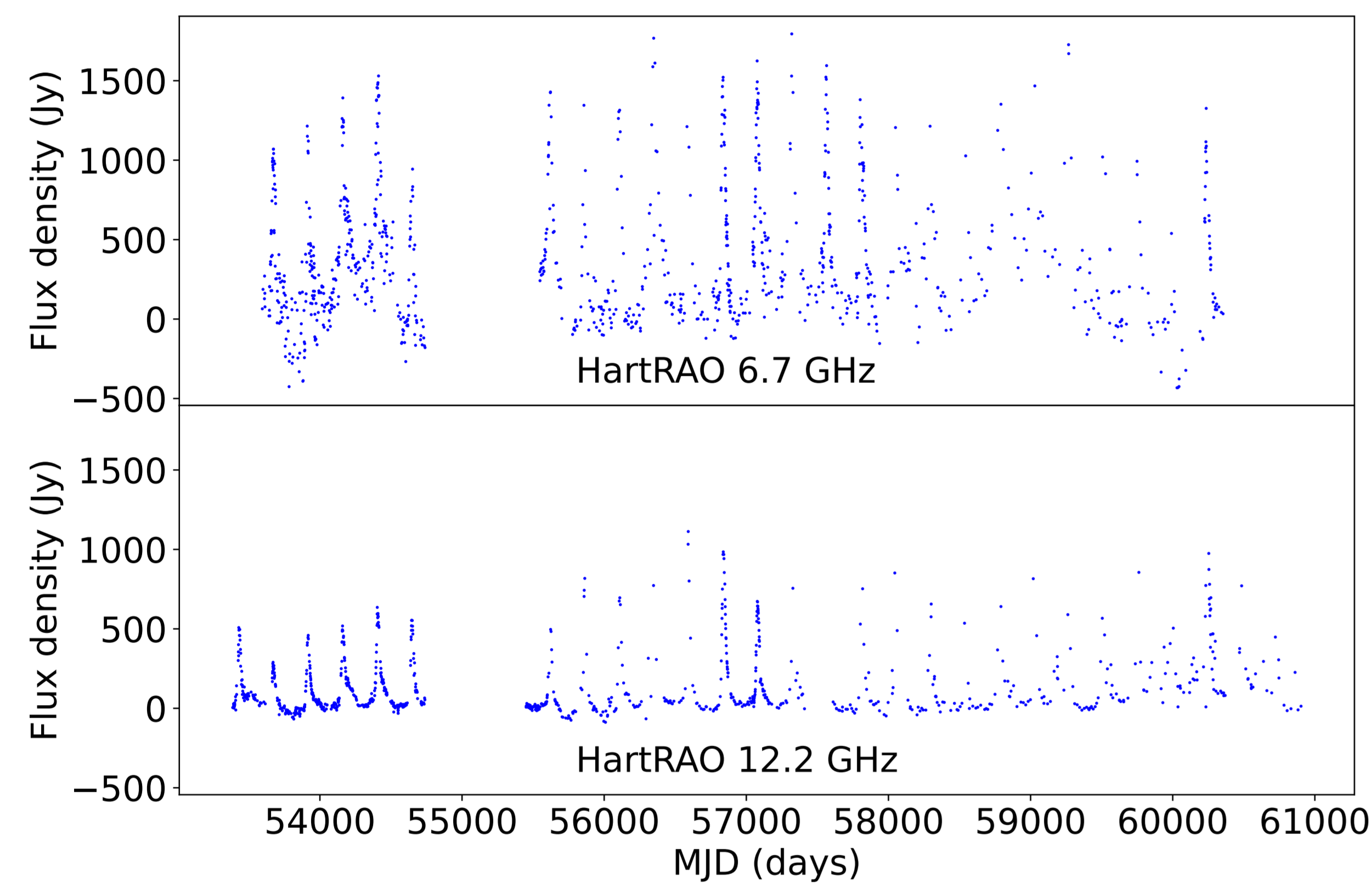
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## Introduction

High-mass star formation is still one of the most enigmatic phenomena, and it is very challenging to understand due to their rarity, embedded nature, and normally at very large distances. Although new instruments have made strides towards starting to answer some of the outstanding questions, these objects are still very difficult to spatially resolve. However, in the last 2-3 decades it has been established that microwave amplification by Stimulated Emission of Radiation (Maser) is exclusively associated with high-mass star formation. On top of that, a small number of these high-mass star forming regions show that the brightness of the associated masers vary periodically/regularly with time. The first to be discovered was the source G009.62+0.20E.



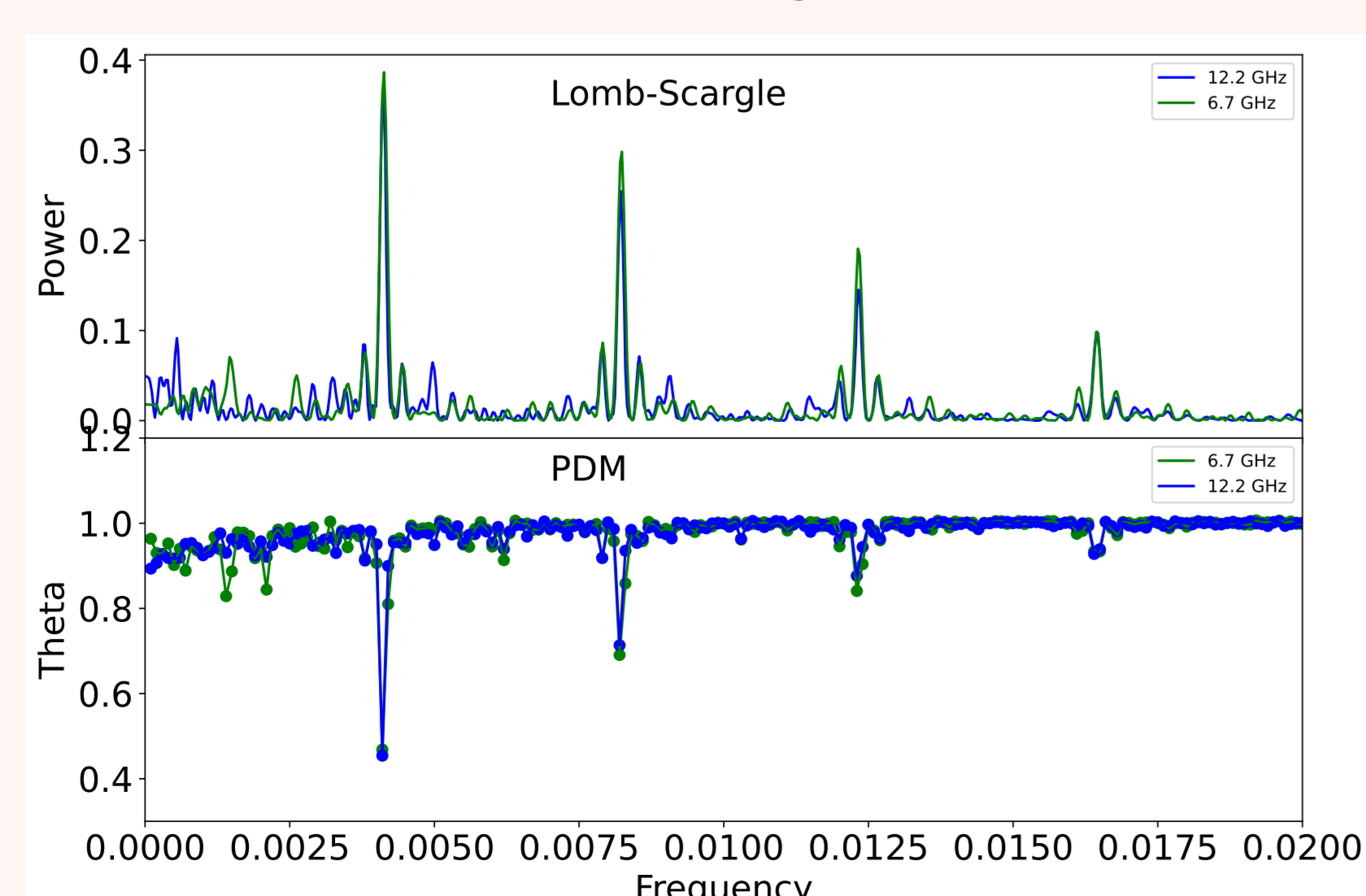
## Is the period really stable?

This is a list of methods used to test this question.

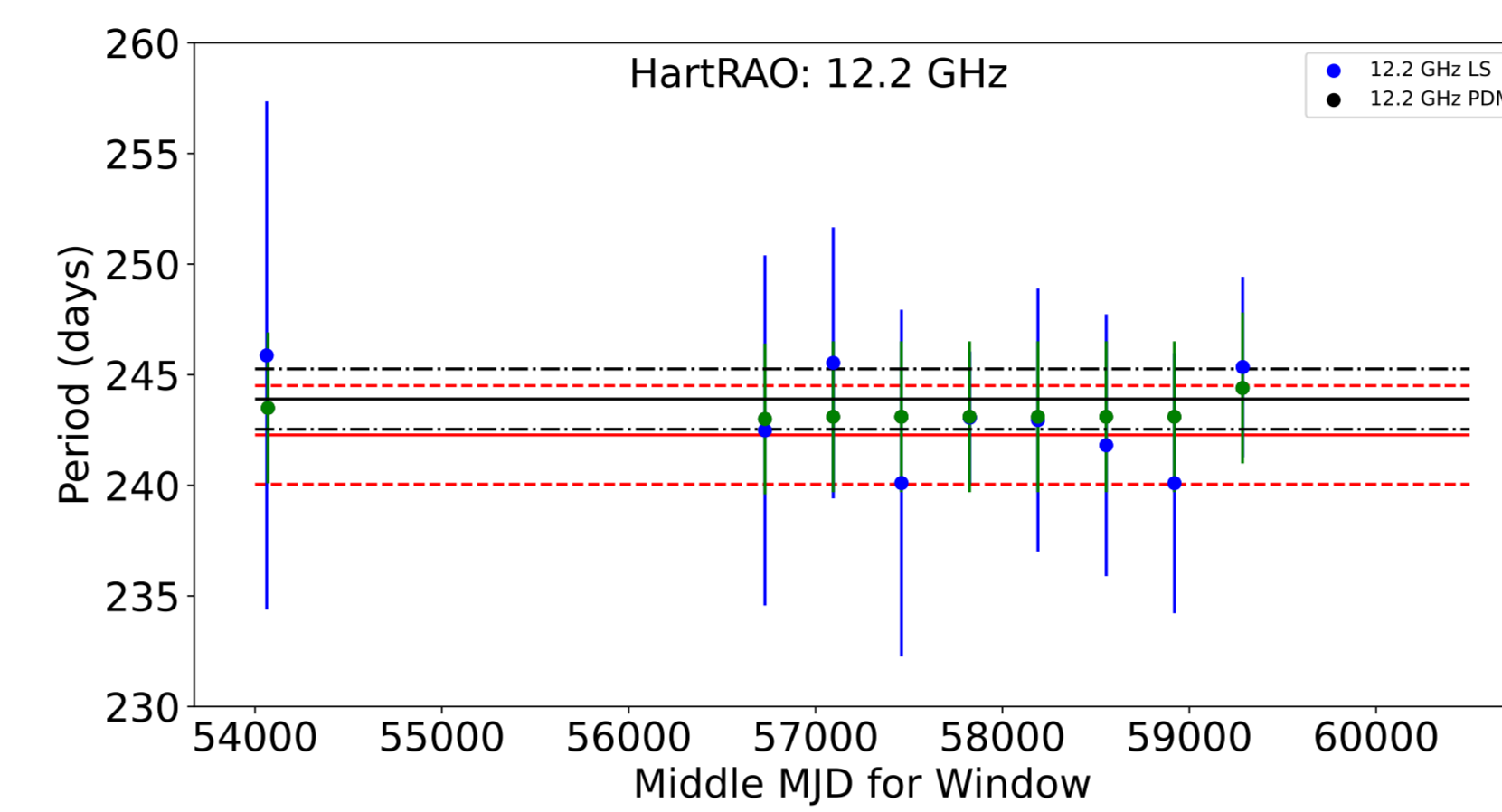
- Apply a Lomb-scargle (LS) periodogram on both 6.7 GHz and 12.2 GHz data
- Apply a Phase Dispersion Minimalization (PDM) on the 6.7 GHz and 12.2 GHz data.
- Repeat for sliding windows in the time series.
- Given the period derived, apply phase folding on both time series.
- Apply a Kernel Density Estimator (KDE) to the folded data.
- See how the duty circles compare between frequencies.

## Period determination

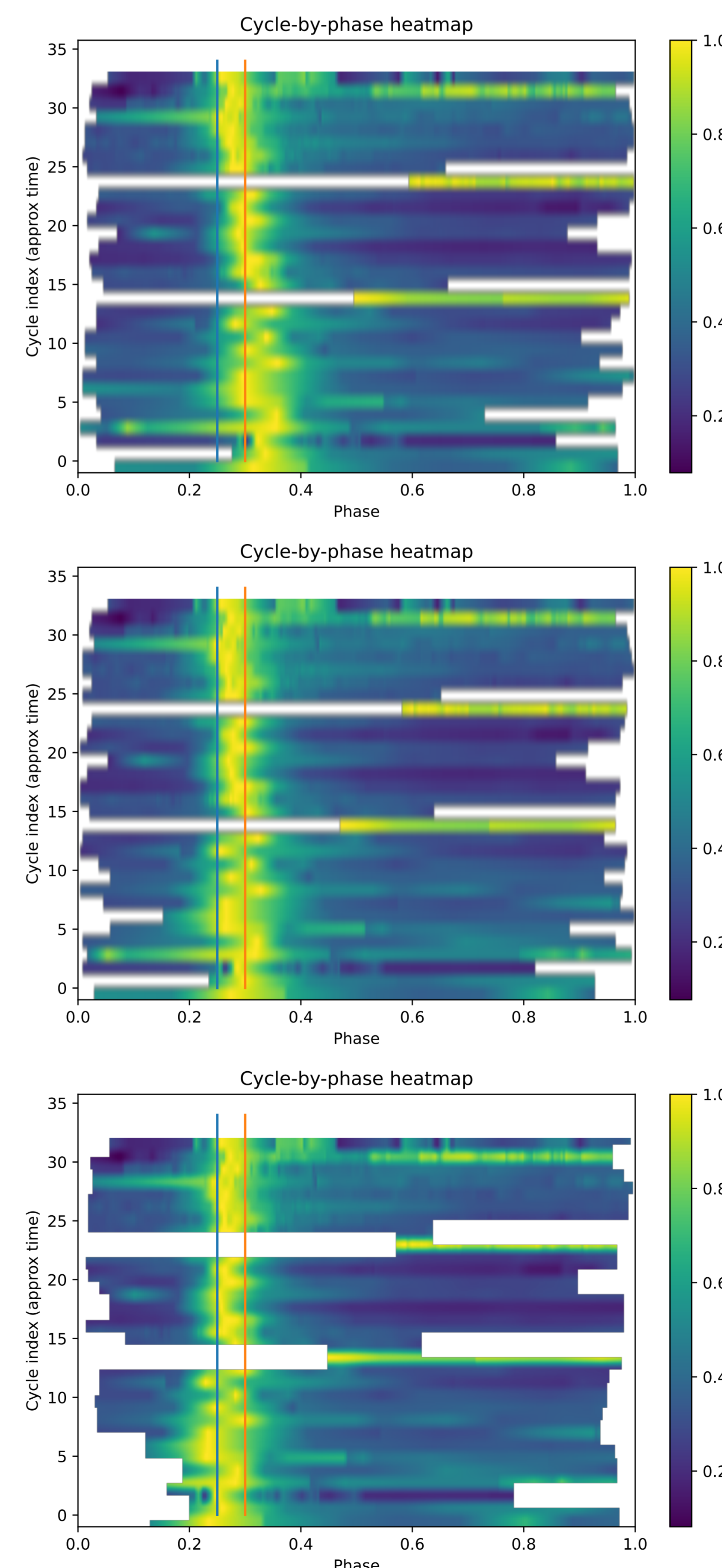
The period is very well constrained by using both the LS and the PDM method.



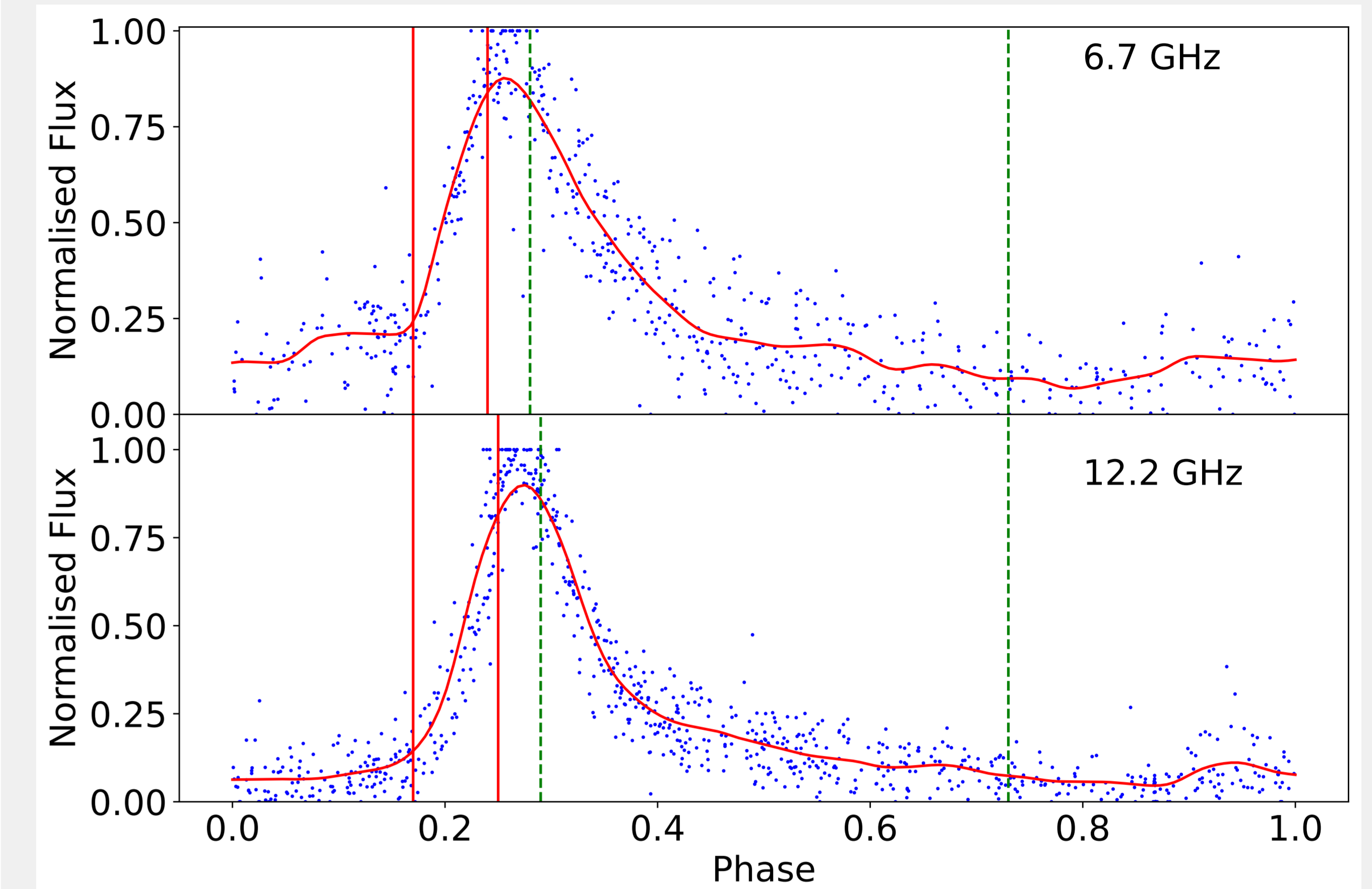
## Period determination and Phase folding



Both the LS and PDM were repeated for several sliding windows (seven year intervals within the entire time series), to see how well the periods of each window compared to the period over the entire time series. It shows that the periods do correspond, but the period determined from the entire time series is much more constrained. This can also be seen from previous work on this source [1, 2], where the error has been much better constrained over time. The period has been determined as  $P = 243.0$  days. The phase plots that the period cannot even have a uncertainty of 0.3 days.



## Normalized flare shape and duty cycle



Phase	6.7 GHz(phase/days)	12.2 GHz(phase/days)
Quiescent	0.45 (109)	0.45 (109)
Rise	0.07(17)	0.08(19)
Top	0.04(9)	0.04(9)
Decay	0.43(107)	0.43(104)

Table 1. A table caption.

This is highly repeatable at both frequencies, and the duty cycle of the different parts of the period is very stable and almost identical. This indicates a highly repeatable mechanism, what can this be?

## Colliding wind binary

The known hypothesis of a colliding wind binary (CWB) is a very likely suspect to explain this periodic methanol maser. The periodic methanol masers in G009.62+0.20E can be very well described within the colliding wind binary model [5, 4, 3].

## References

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