The Intriguing Accreting White Dwarf Pulsators

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Introduction to Accreting White Dwarf Pulsators

- In 1998, pulsations were observed in the cataclysmic variable GW Librae. We now know of 12-14 accreting white dwarf pulsators.

- Mass transfer rate is very low $dM/dt \sim 10^{-11}\ M_{sun}/yr$.

- Members of this class are found near the orbital period minimum $P_{orb} \sim$ 80-90 min.

- About 90% of the optical light comes from the white dwarf.

Empirical instability strip for accreting pulsators

Accreting White Dwarf	Temperature (K)	Pulsating during Spectroscopy
V455 And	10500	Yes
PQ And	12000	Ambiguous
REJ 1255	12000	Ambiguous
SDSS1339+4847	12500	No
SDSS0919+0857	13500	No
SDSS1610-0102	14500	Yes
SDSS0131-0901	14500	Yes
SDSS2205+1155	15000	Yes
GW Librae	15400	Yes

Uncertainties of the order of 1000K (Fits by B. Gänsicke)

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Broad instability strip in the range of 10500K to 15400K

Non-pulsators in the range of 10000K to 15000K

(Szkody et al. 2010)

Empirical instability strip for accreting pulsators

Accreting White Dwarf	Temperature (K)	Pulsating during Spectroscopy
V455 And	10500	Yes
SDSS1339+4847	~12500	
SDSS0919+0857	~13500	
SDSS1610-0102	14500	Yes
SDSS0131-0901	14500	Yes
SDSS2205+1155	15000	Yes
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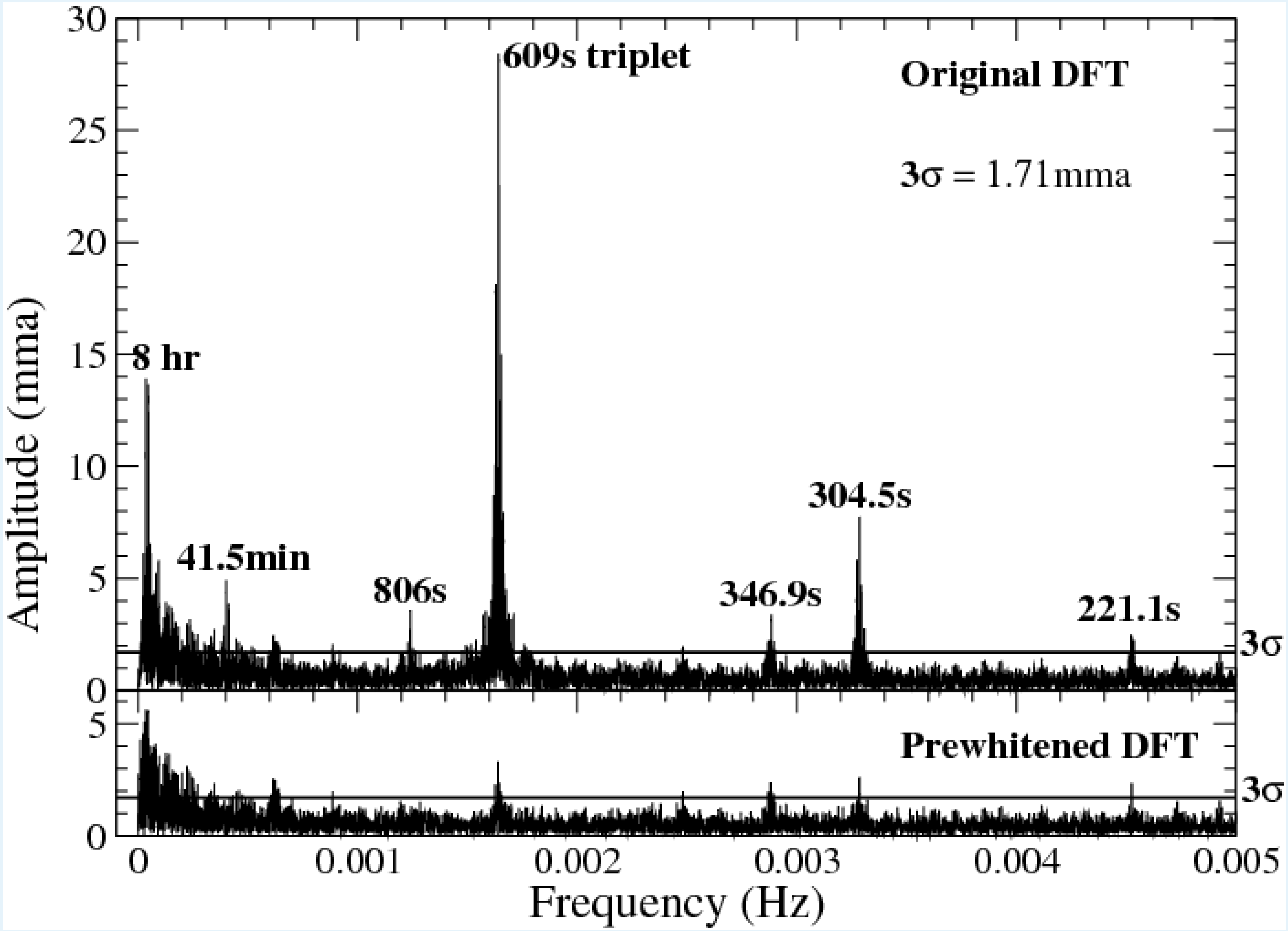
Theoretical Instability Strip for accreting pulsators
Arras et al. (2006)

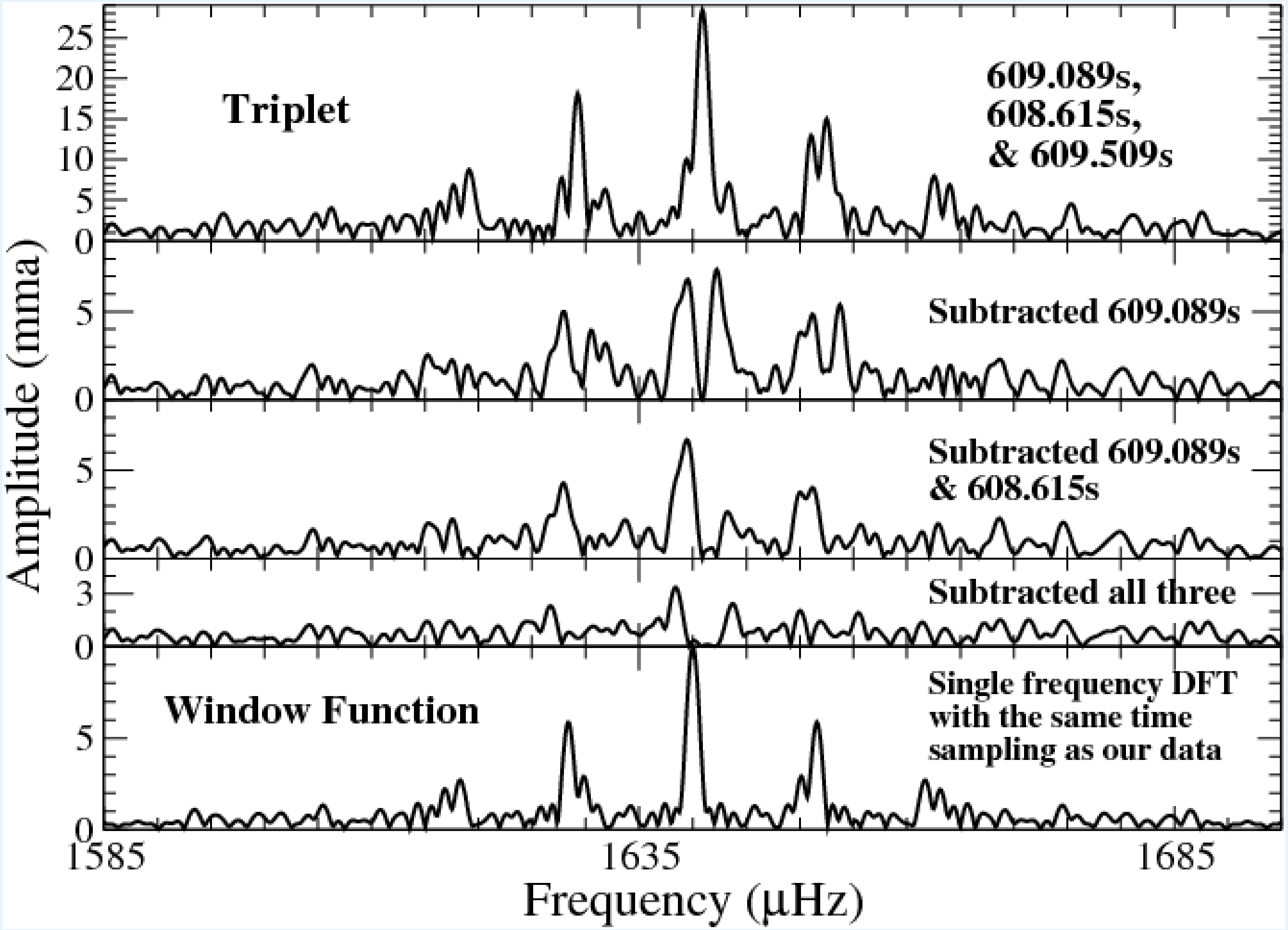
- H/HeI instability strip with a blue edge at 12000K, similar to the ZZ Ceti instability strip.
- For a He abundance >0.38, HeII instability strip at about 15000K.
- For a He abundance >0.48, these strips merge.
- Our results so far are consistent with theory.

Multi-site Campaign on SDSS1610-0102



Frequency Stability over 3-4 years

Evenly Spaced Rotational Triplet at 609s



Spacing of 1.2 µHz implies a rotation period of 4.8 days!

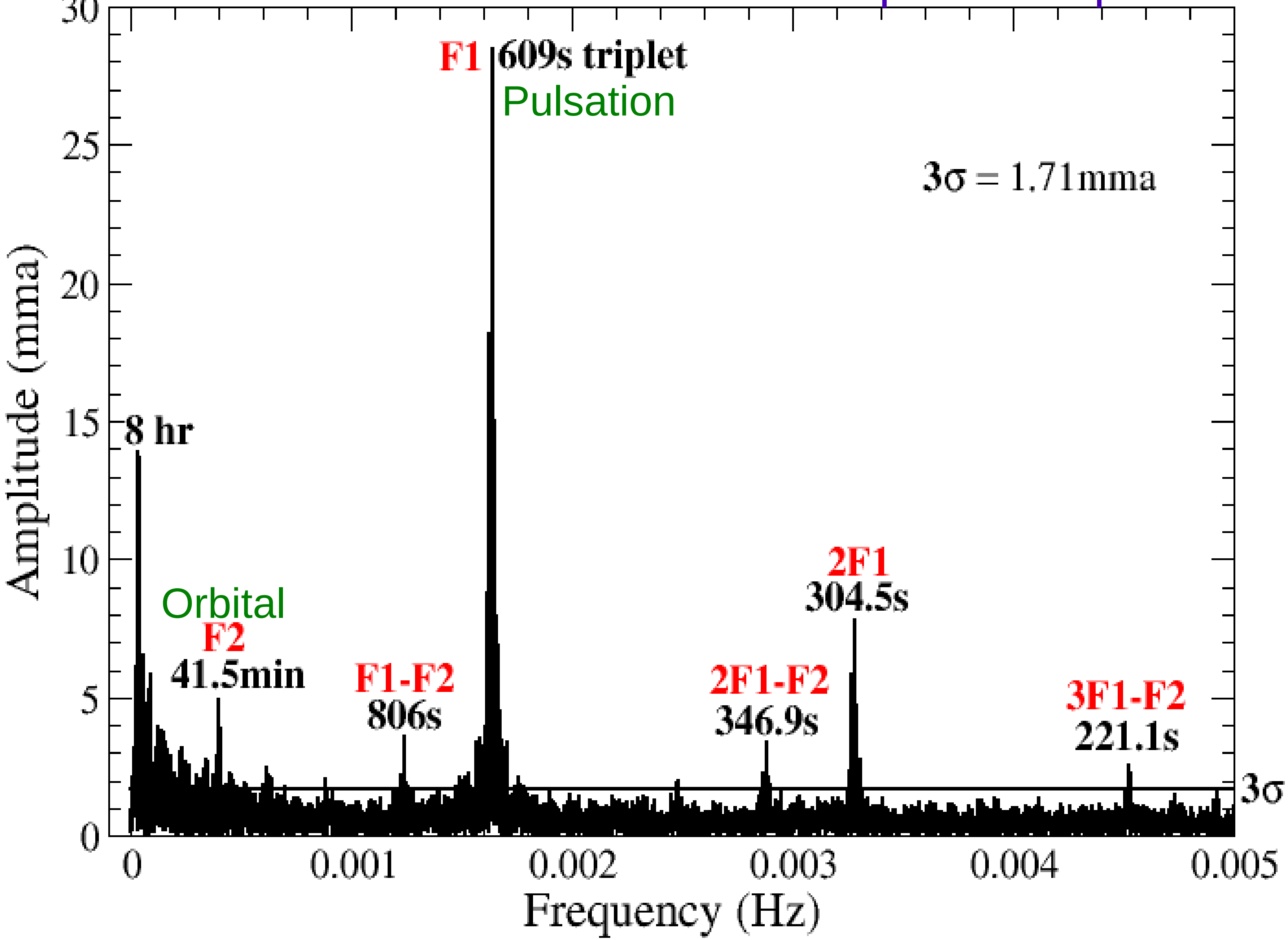
Implications of the observed 609s triplet

- Remarkably long rotation period for an accreting white dwarf with an orbital period of 83min. Loss of angular momentum during outbursts could cause the white dwarf to spin down.

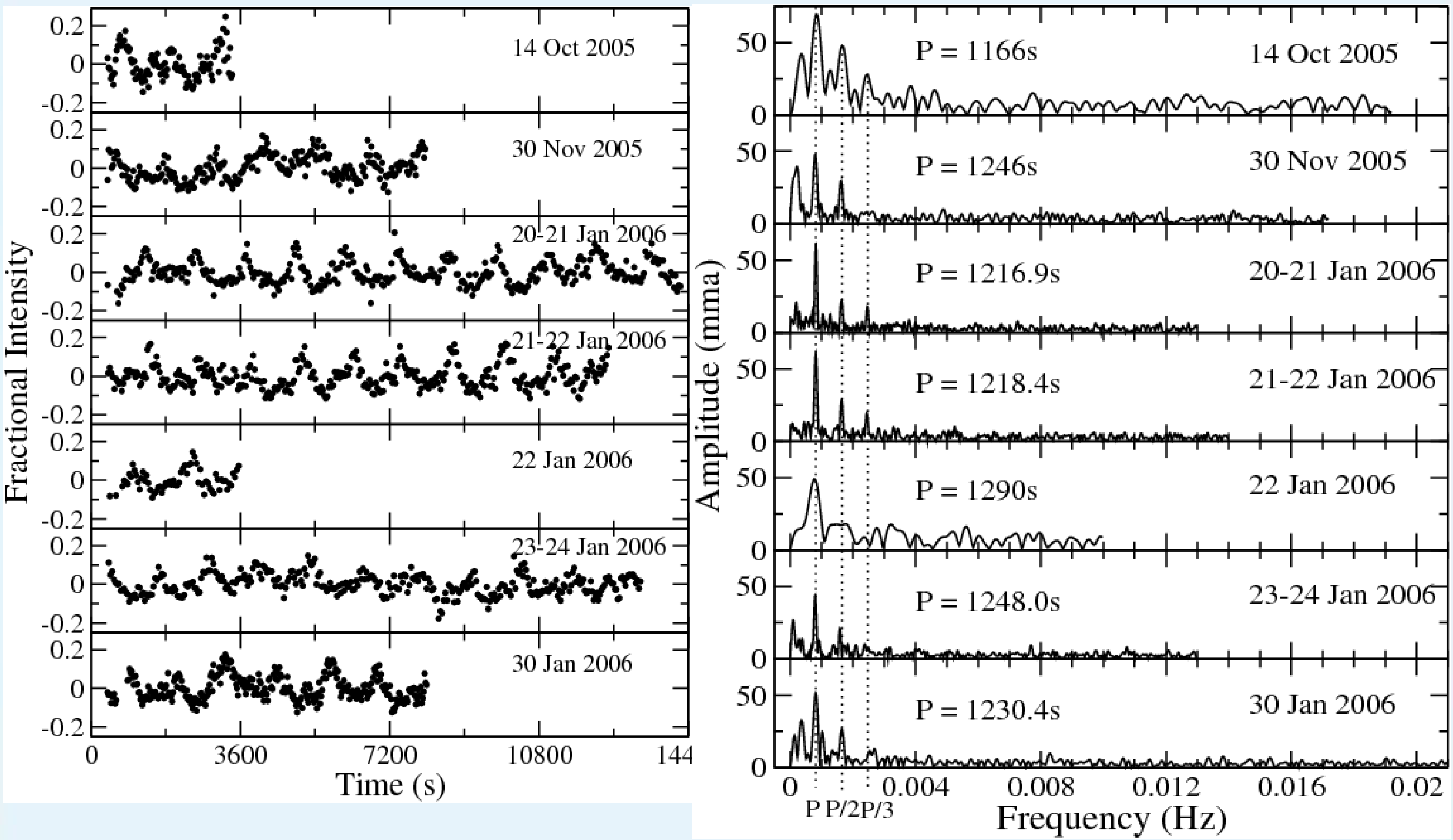
- Possibility of differential rotation with a slow rotating exterior and rapid rotation in the interior.

- GW Librae also shows an unresolved multiplet structure with an approximate 1μHz spacing for both the 370s and 650s modes (van Zyl et al. 2004).

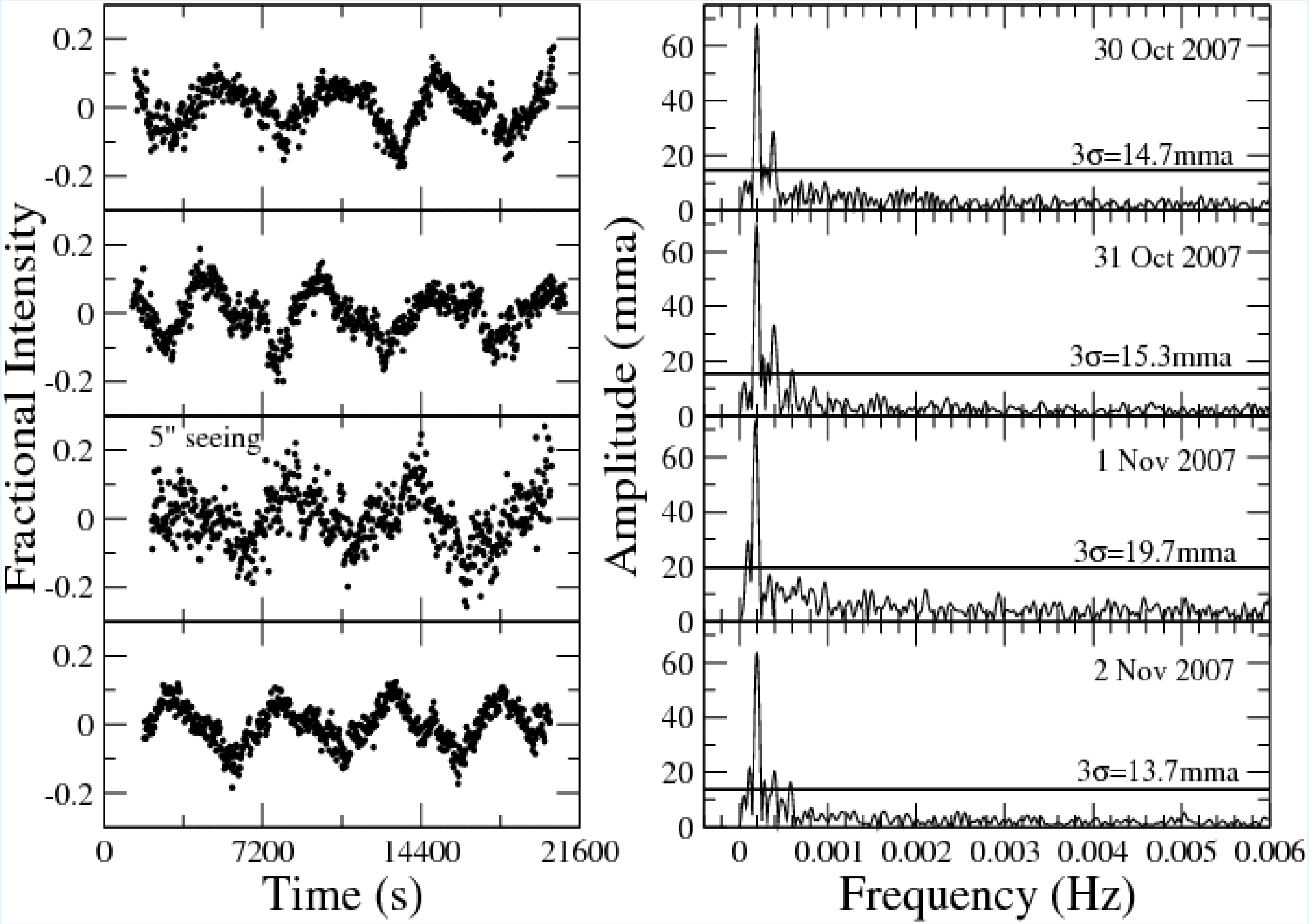
Linear combinations of the orbital and pulsation periods



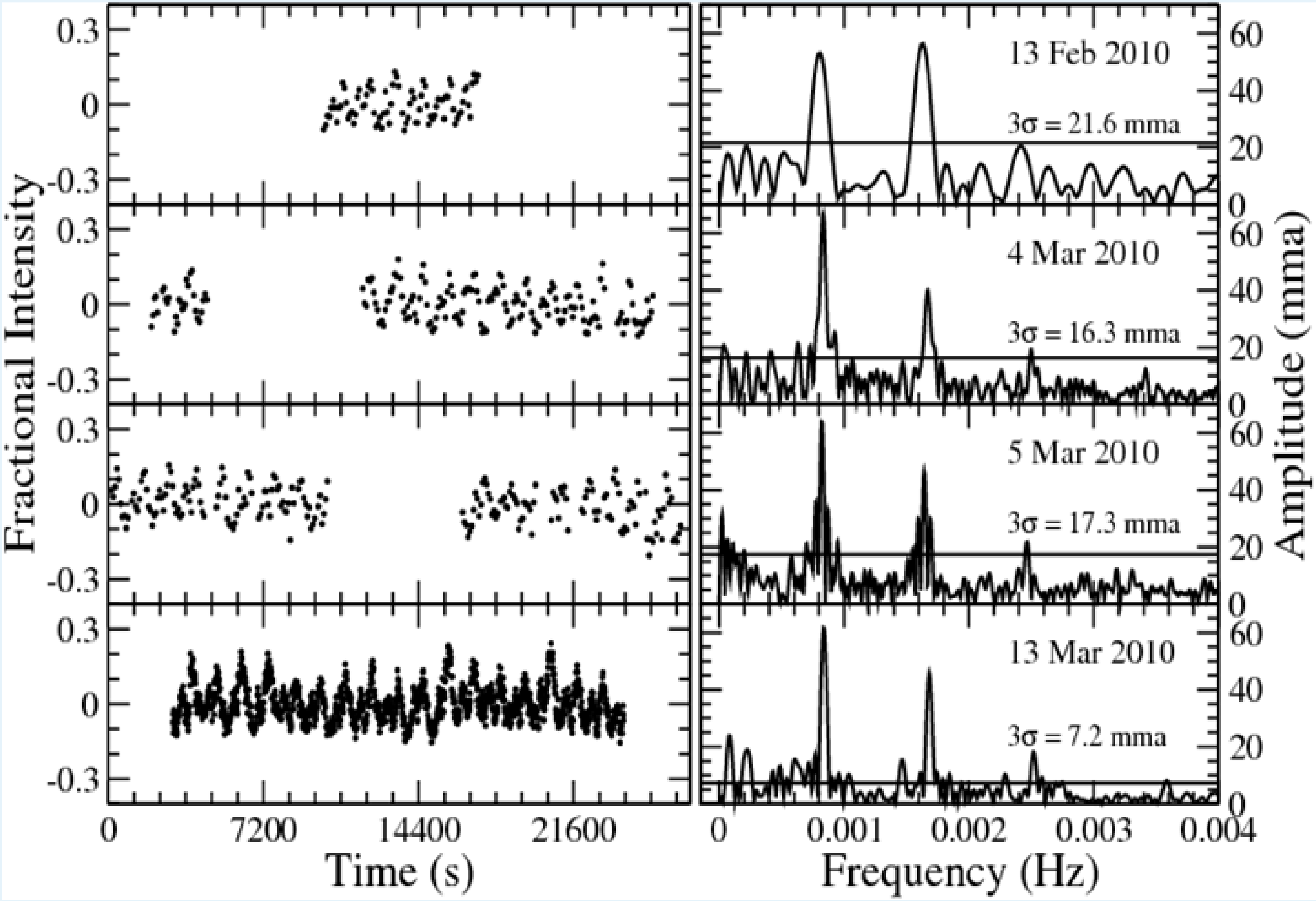
Discovery Data on SDSS0745+4538



No sign of pulsations a year after Oct 2006 outburst



Pulsating 3.5 years after its October 2006 outburst: SDSS0745+4538



Comparing post-outburst & matching pre-outburst pulsation periods

Post-Outburst Periods (s)	Pre-Outburst Periods (s)
1232.1 ± 2.2	1228.6 ± 1.8
1200.9 ± 1.1	1199.48 ± 0.92 1199.5 ± 1.3
1216.98 ± 0.35	1216.07 ± 0.71
1190.1 ± 1.0	1193.5 ± 1.0

Periods match within uncertainties for all cases except one

Implications of observing the same periods before & after outburst

- The quiescent temperature of SDSS0745+4538 is 11000 ± 2000K (Mukadam et al. 2007).

- The effective temperature measured a year after outburst was about 16500 ± 1000K (Szkody et al. 2010).

- The **outburst did not cause any significant heating or other changes in the central core**, even though the envelope got heated. Else the eigenfrequencies would have revealed the modified stellar structure.

- Dean Townsley (U. Arizona) is working on modeling these values to calculate the outburst parameters.

Bottom Line

Accreting pulsators are becoming more interesting in a seismological context!