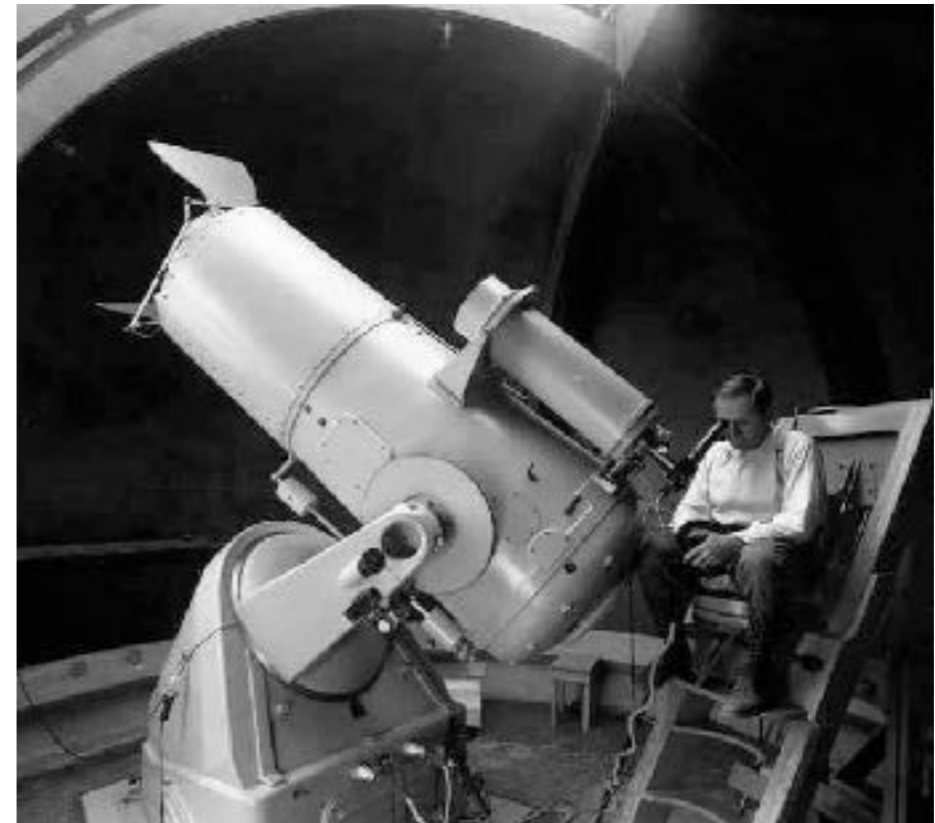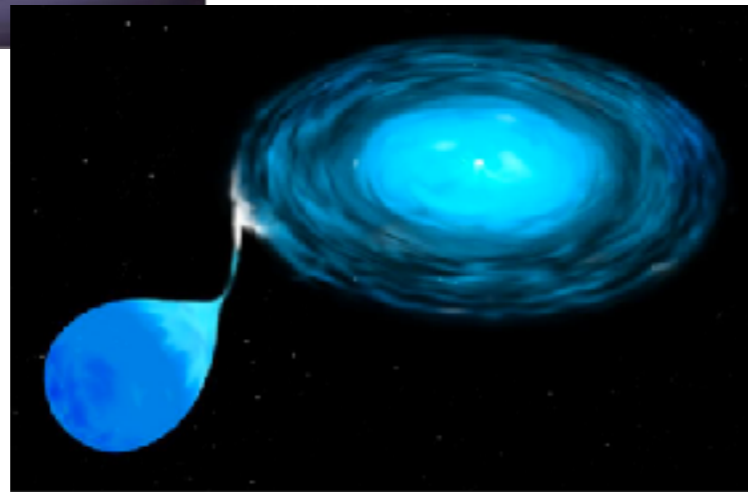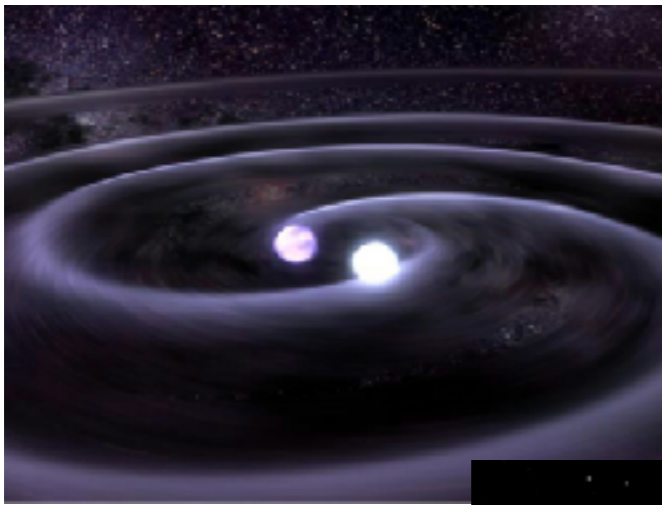# Exotic variables from ZTF
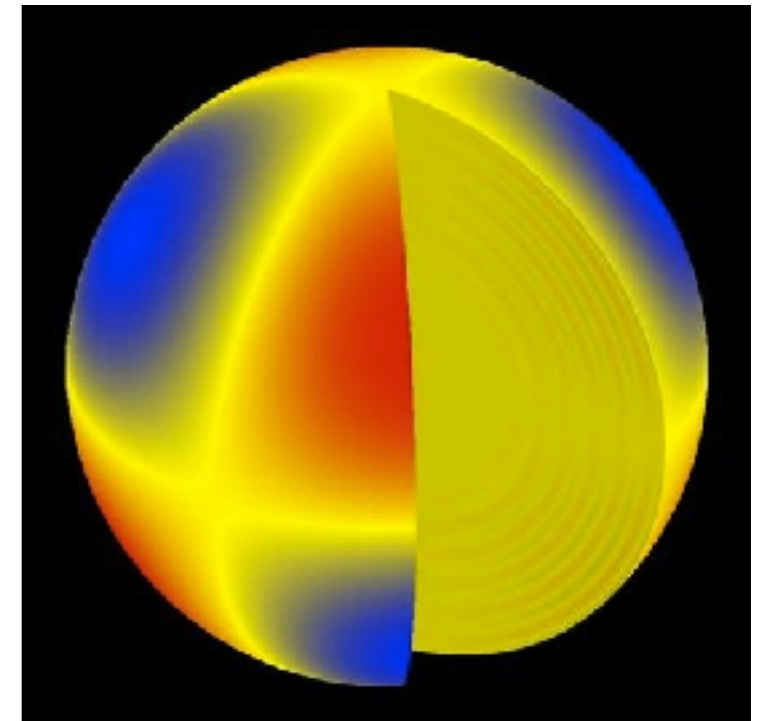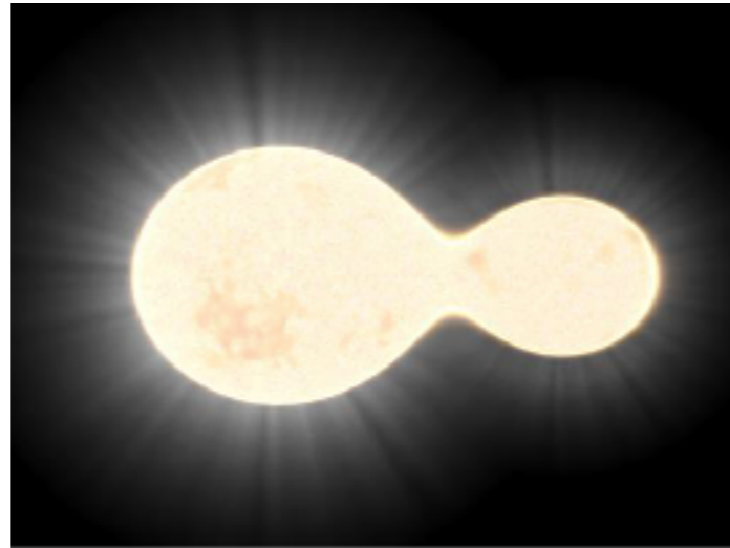
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Stellar variability is very common

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How did we find them

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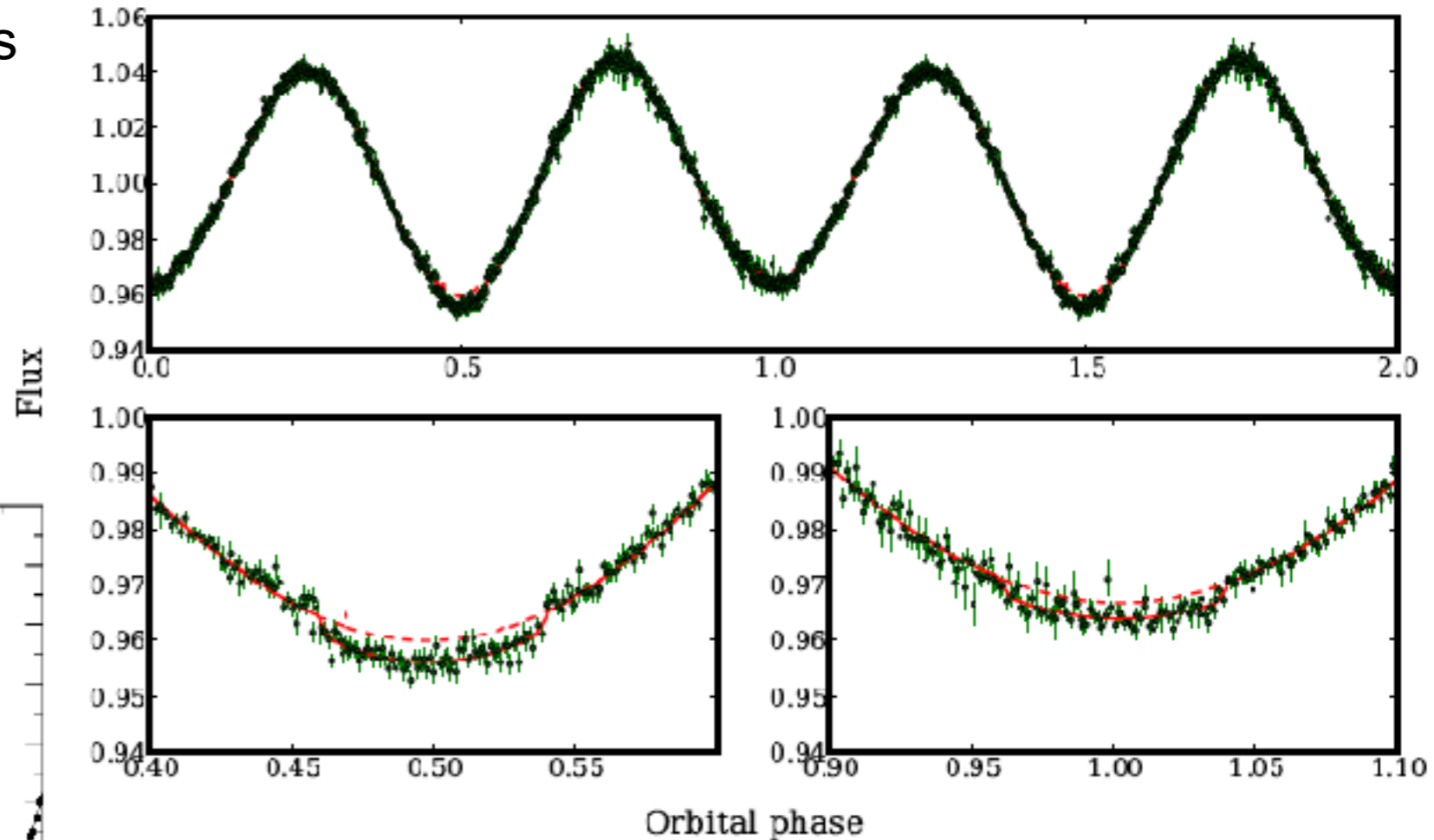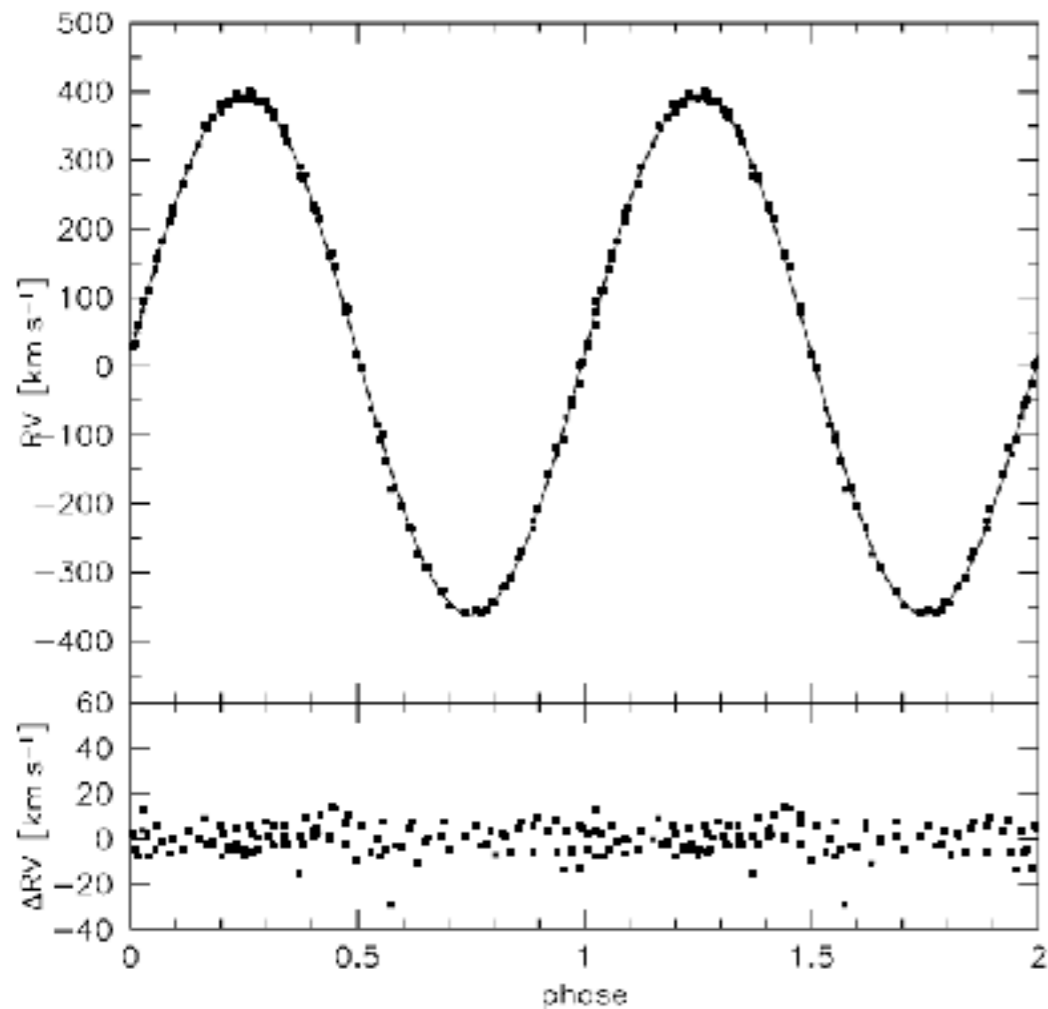
CD-30 11223 - SN Ia progenitor candidate (P_{orb} = 70min) - _found completely serendipitously_

- Lightcurve shows weak eclipses
- Analysis gives:

M_{sdB} = 0.54 M_{sol}; M_{WD} = 0.74 M_{sol}

=> Progenitor system most likely

3 + 4 M_{sol} binary

Will get in contact in about 40 Myr

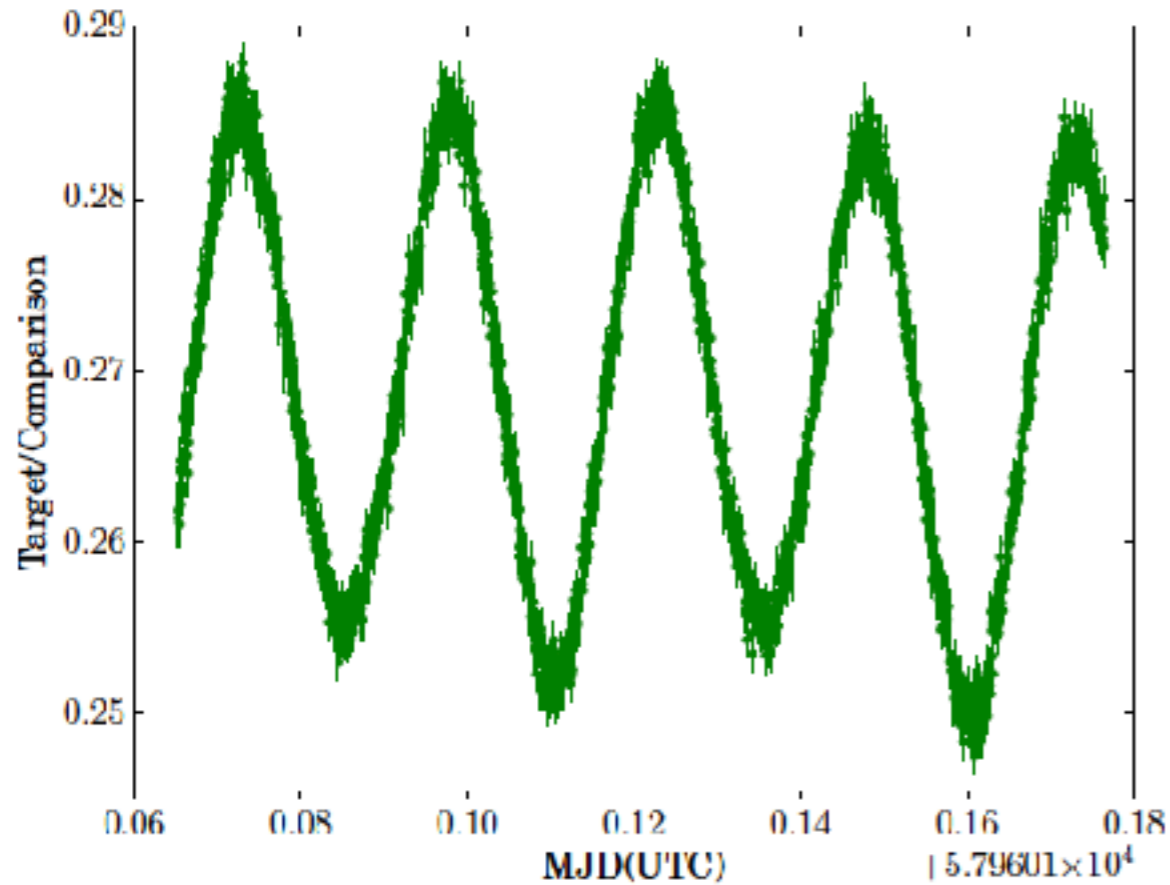**_Will probably explode as SN Ia??_**

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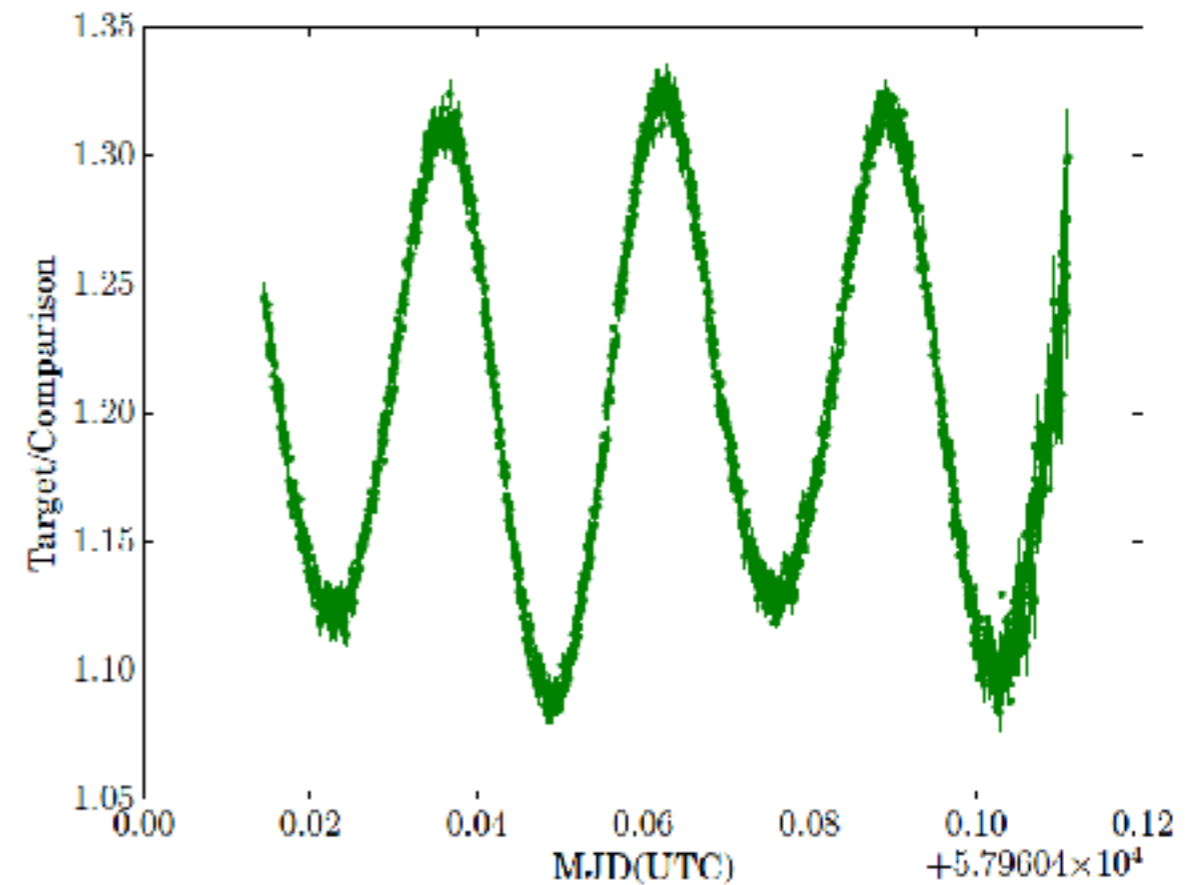Kavli Institute for
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Look for the freaks

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Two new CD-30 like systems from PTF - Parameter (very preliminary)

PTFS1 J1821 (b=13.9deg)

PTFS1 J2238 (b=8.9deg)

- **P_{orb} = 72.1 min**
- M_{sdB} ~ 0.40 M_{sun}
- M_{WD} ~ 0.65 M_{sun}

- **P_{orb} = 76.3 min**
- M_{sdB} ~ 0.35 - 0.4 M_{sun}
- M_{WD} ~ 0.7 - 0.8 M_{sun}

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Look for the freaks

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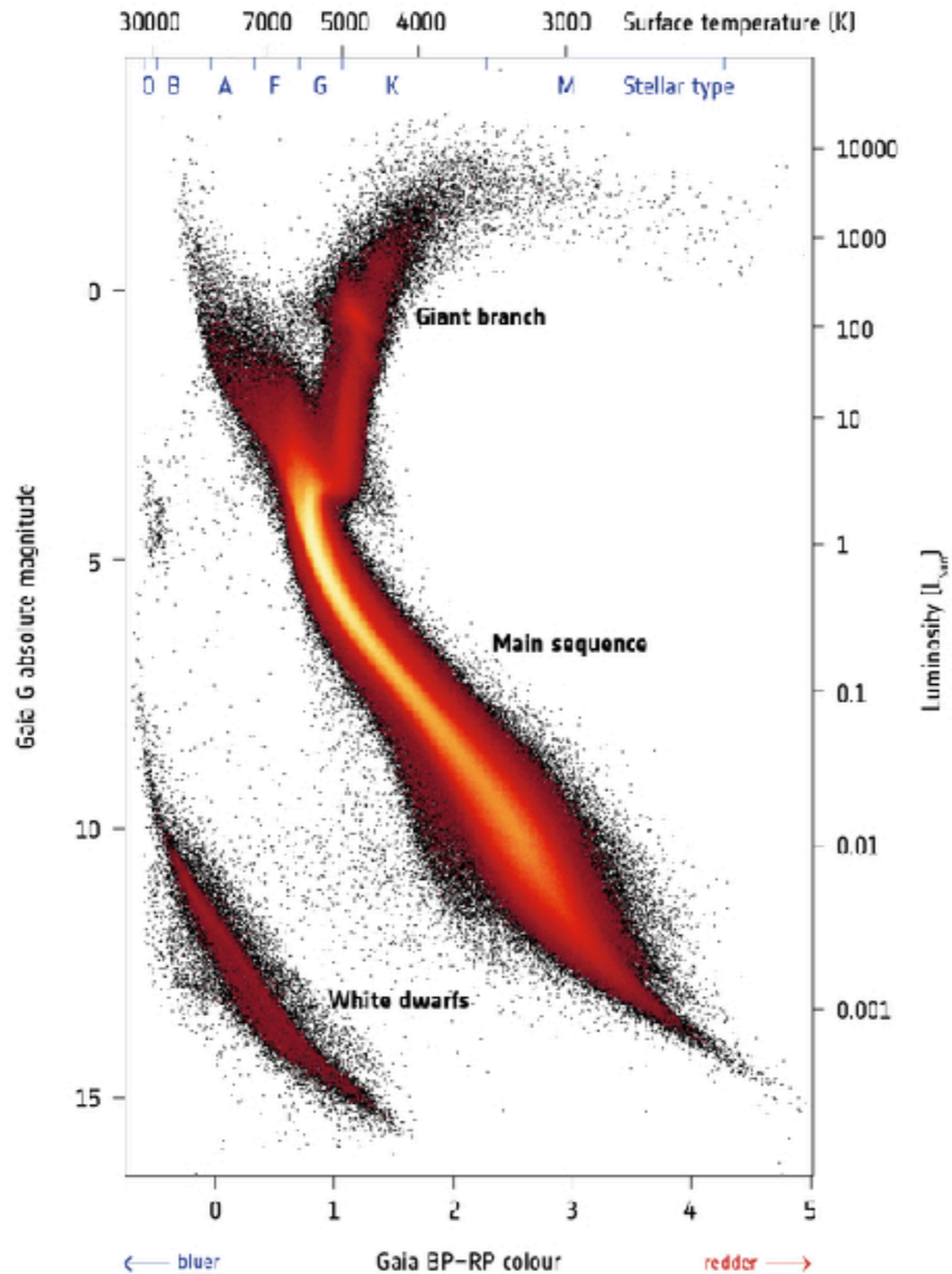
The population of freaks

- hot subdwarfs
- post AGB stars
- AMCVns
- hot pre-WDs
- central stars of PN
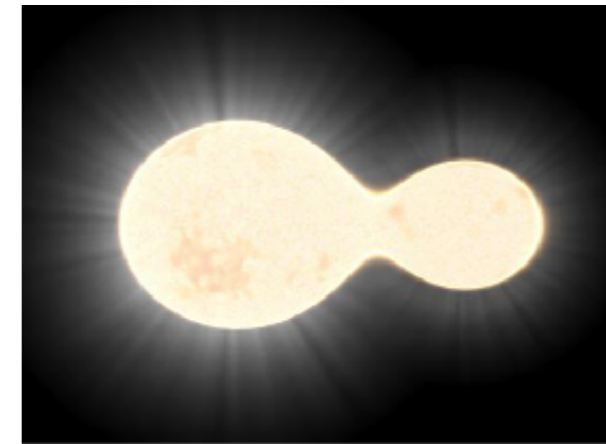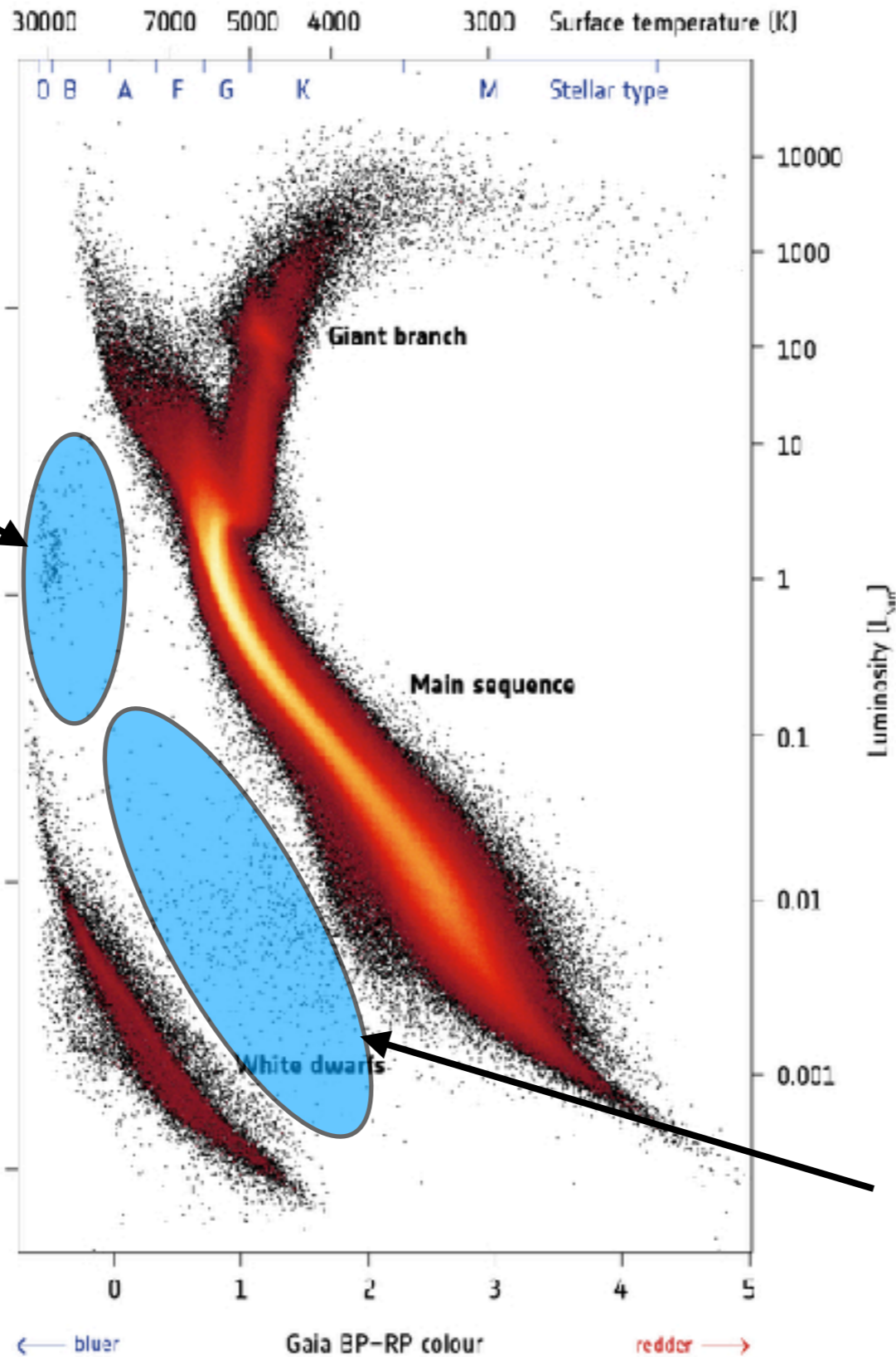
- cataclysmic variables
- extremely low mass WDs
- SN Ia(x) remnants

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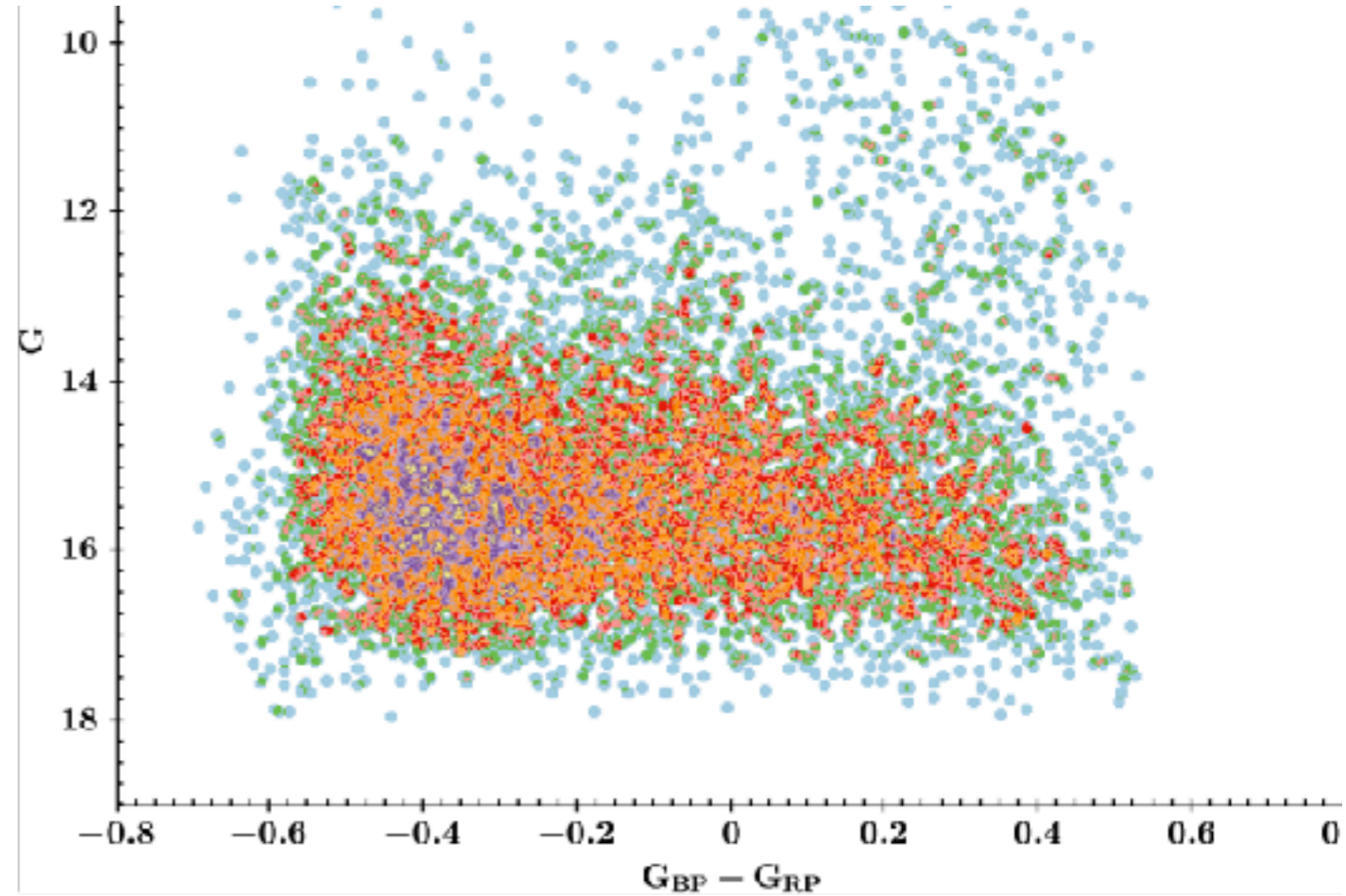Theoretical Physics
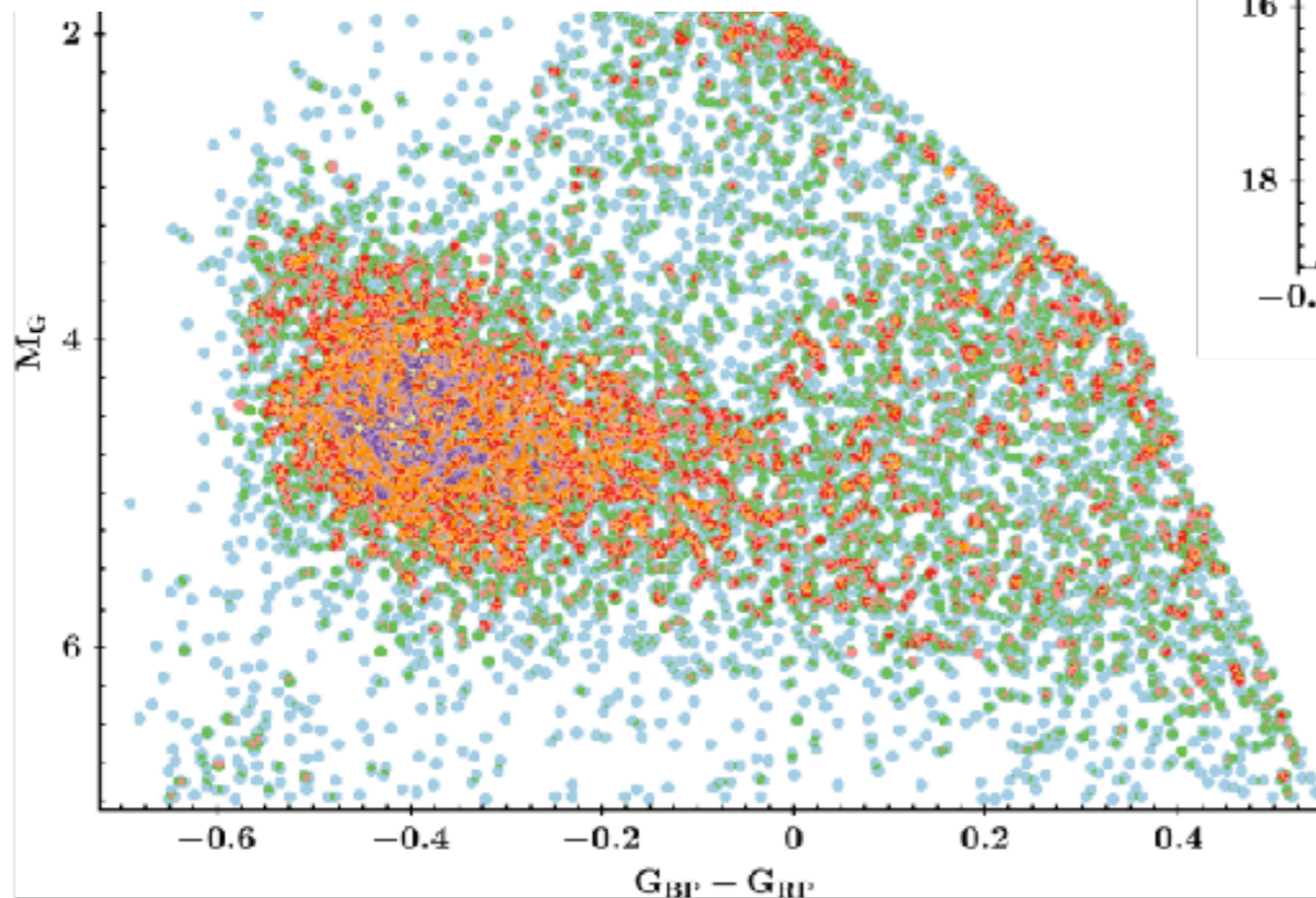University of California, Santa Barbara

The sample of hot subdwarf stars

- **Selection based on:**

  - previously classified
  - parallax
  - reduced proper motion

- **Numbers:**

  - about 9000 selected on parallax
  - Total sample ~40 000
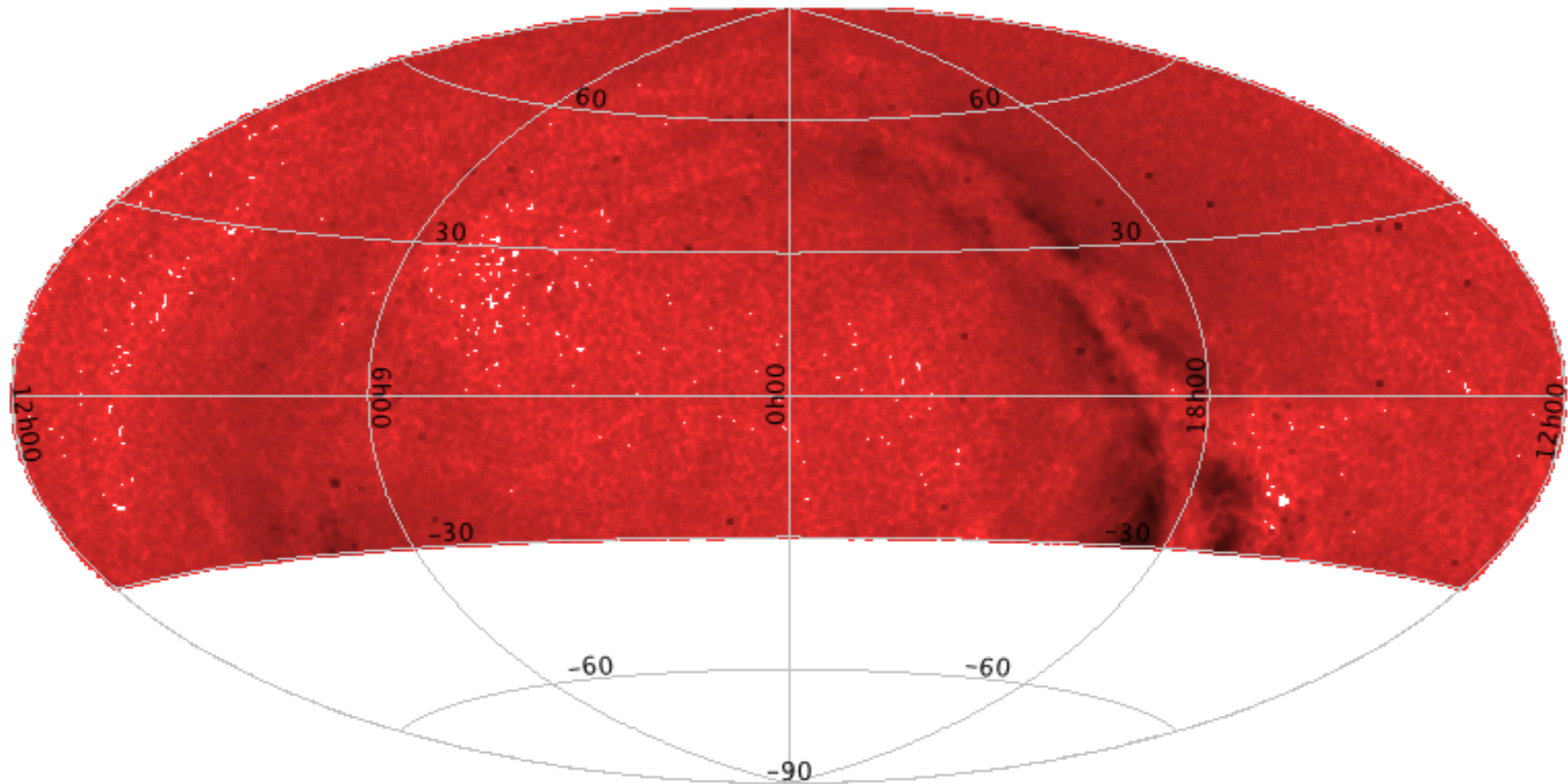
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Data minining

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The ZTF high-cadence Galactic Plane survey

***The fast and the furious - A fast
cadence survey of the Galactic Plane***

- **Time period:** mid 2018 - mid 2019
- **Cadence:** continuous for 2 - 3 hrs
- **Coverage:** ~2500 square degrees

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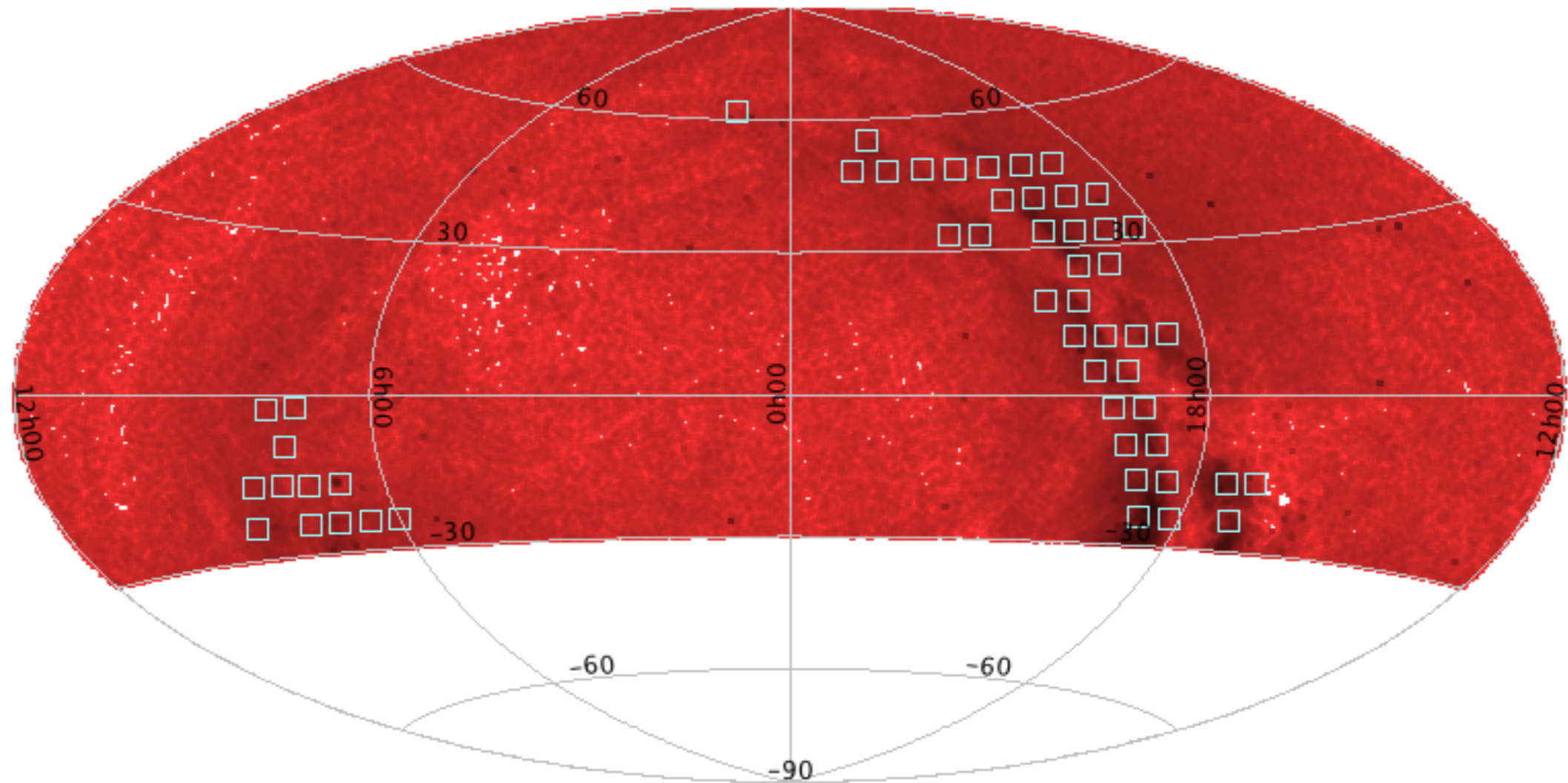Theoretical Physics
University of California, Santa Barbara
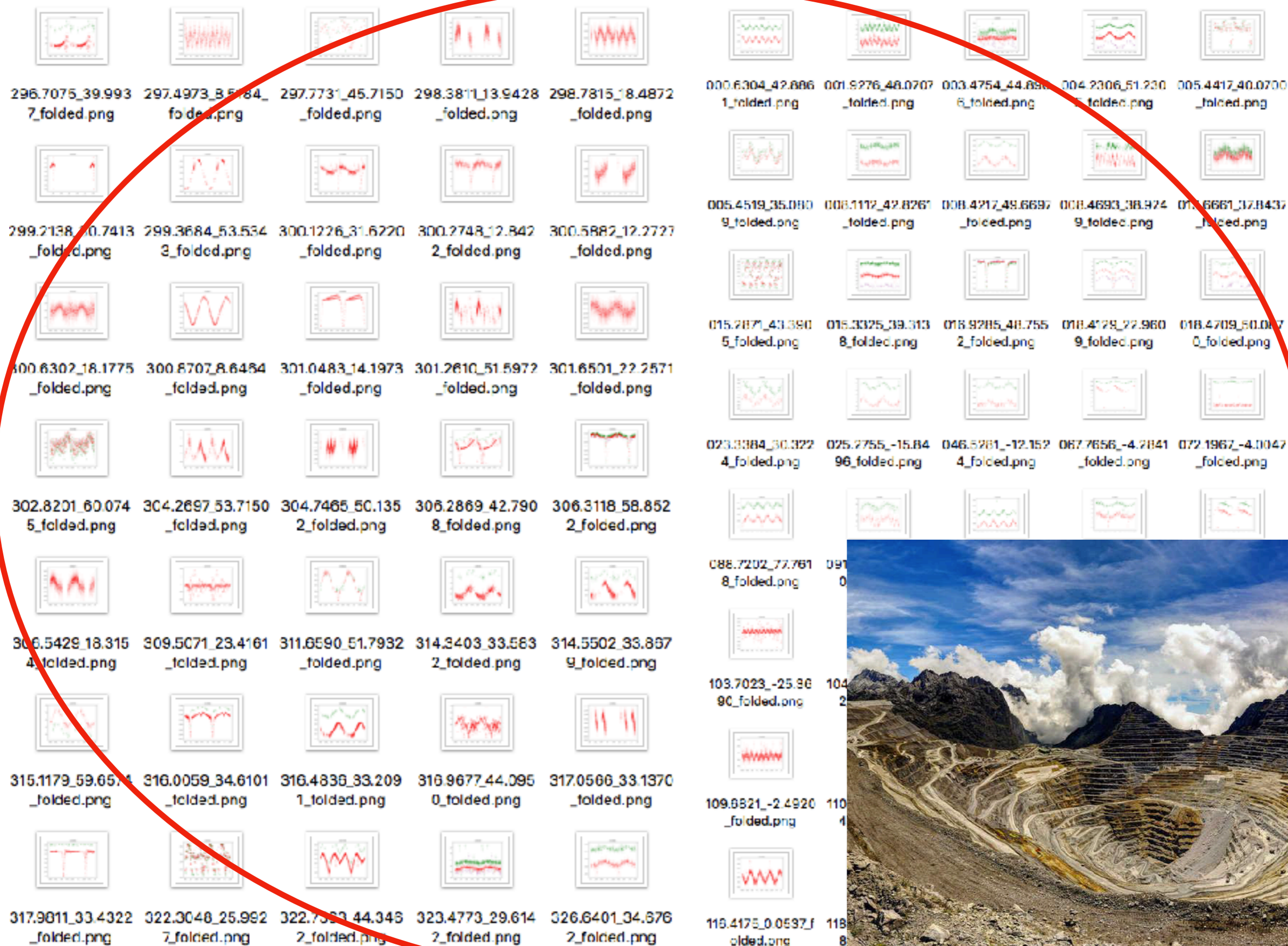
The ZTF high-cadence Galactic Plane survey

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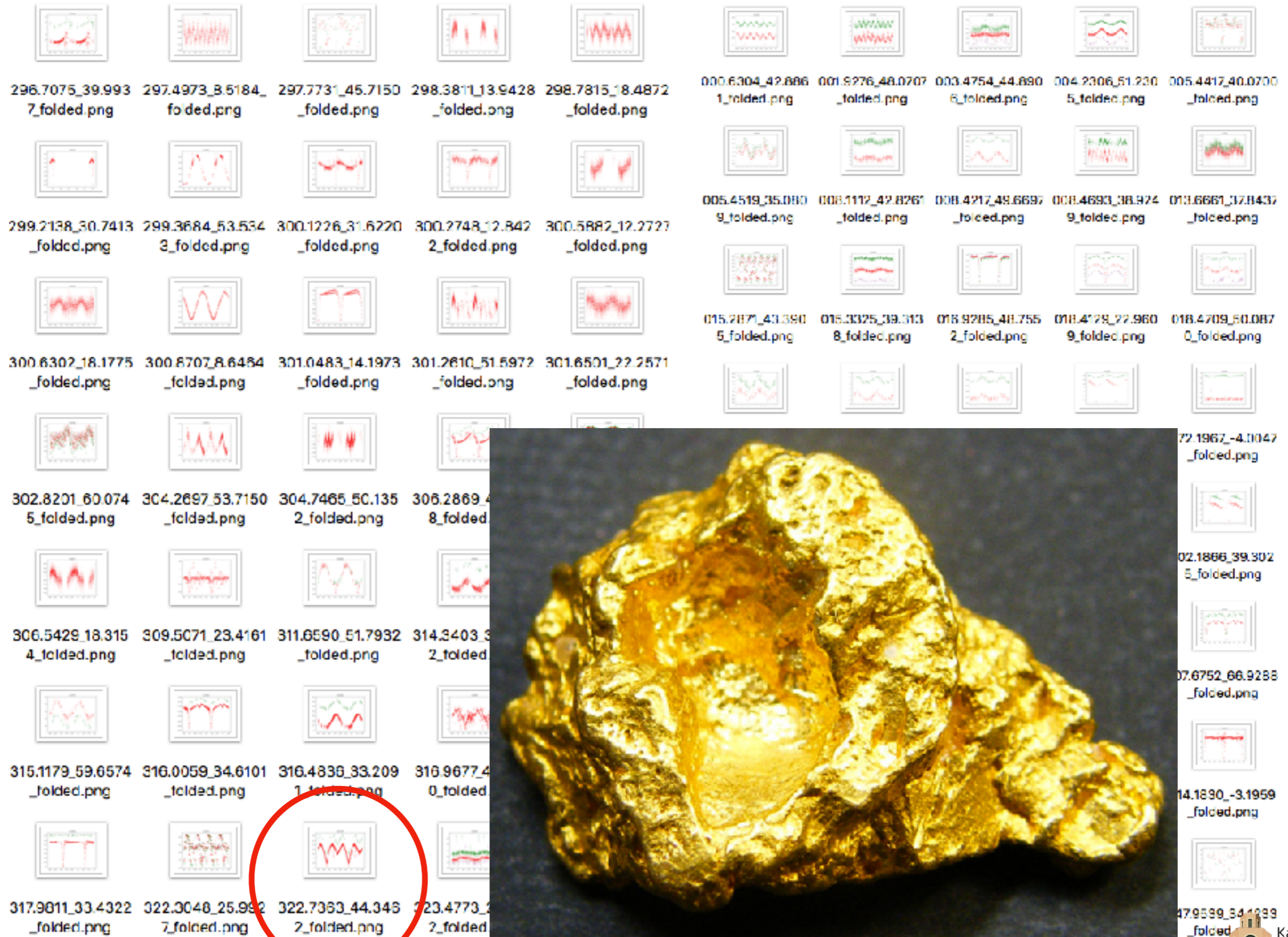- **Coverage:** ~2500 square degrees

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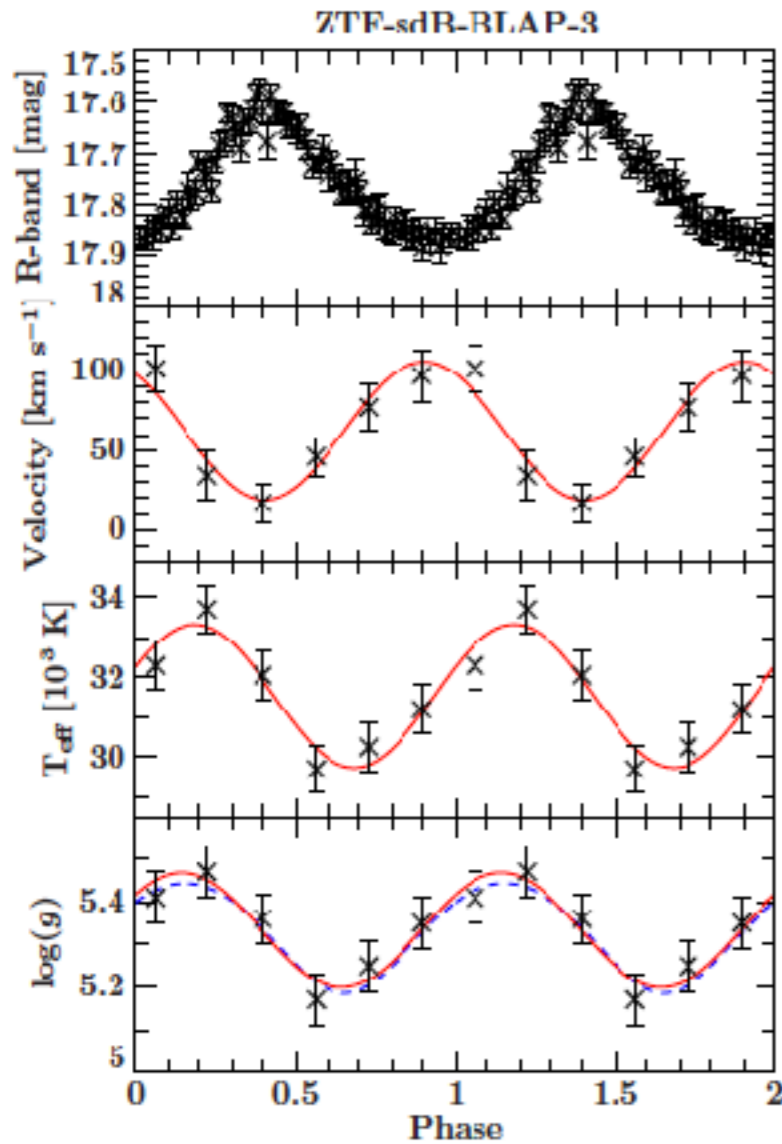Theoretical Physics
University of California, Santa Barbara

Include time-domain information

Include time-domain information

Include time-domain information

Kavli Institute for
Theoretical Physics
University of California, Santa Barbara
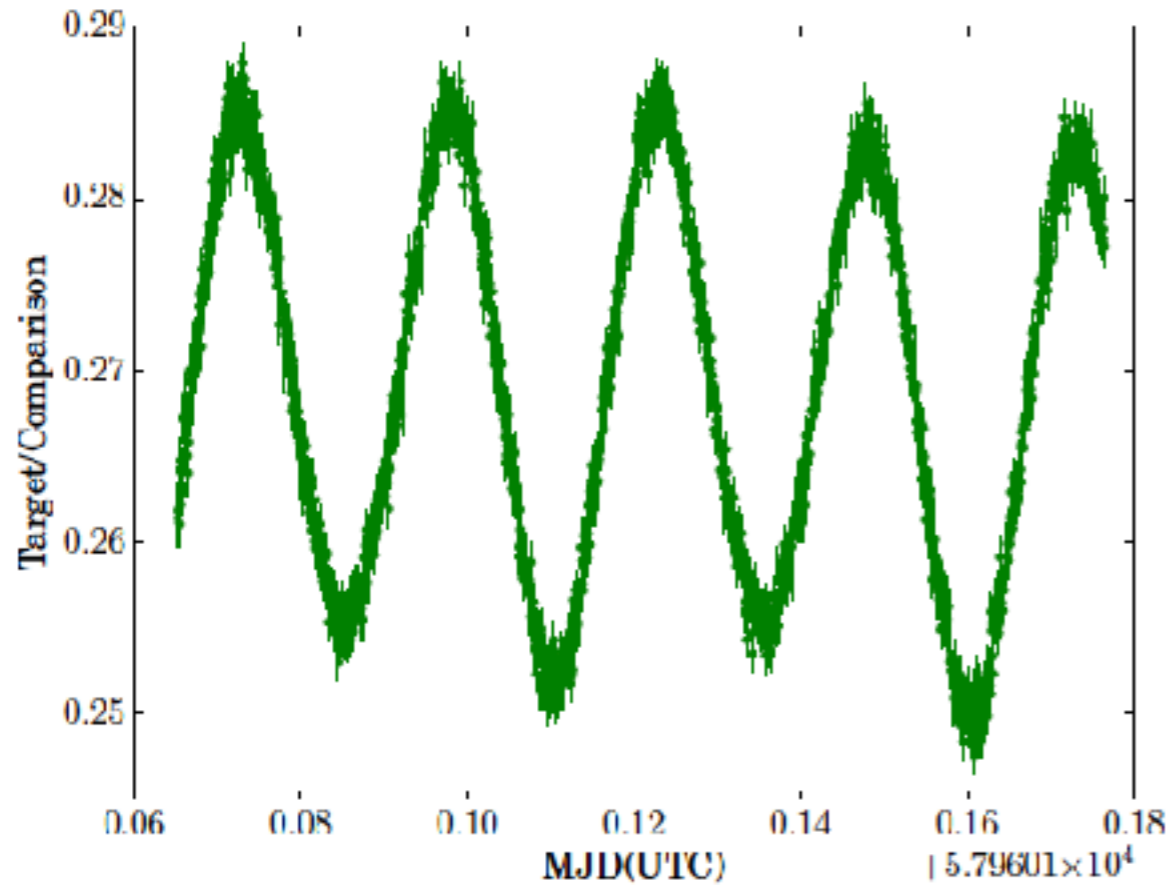
A new class of radial mode hot subdwarf pulsators
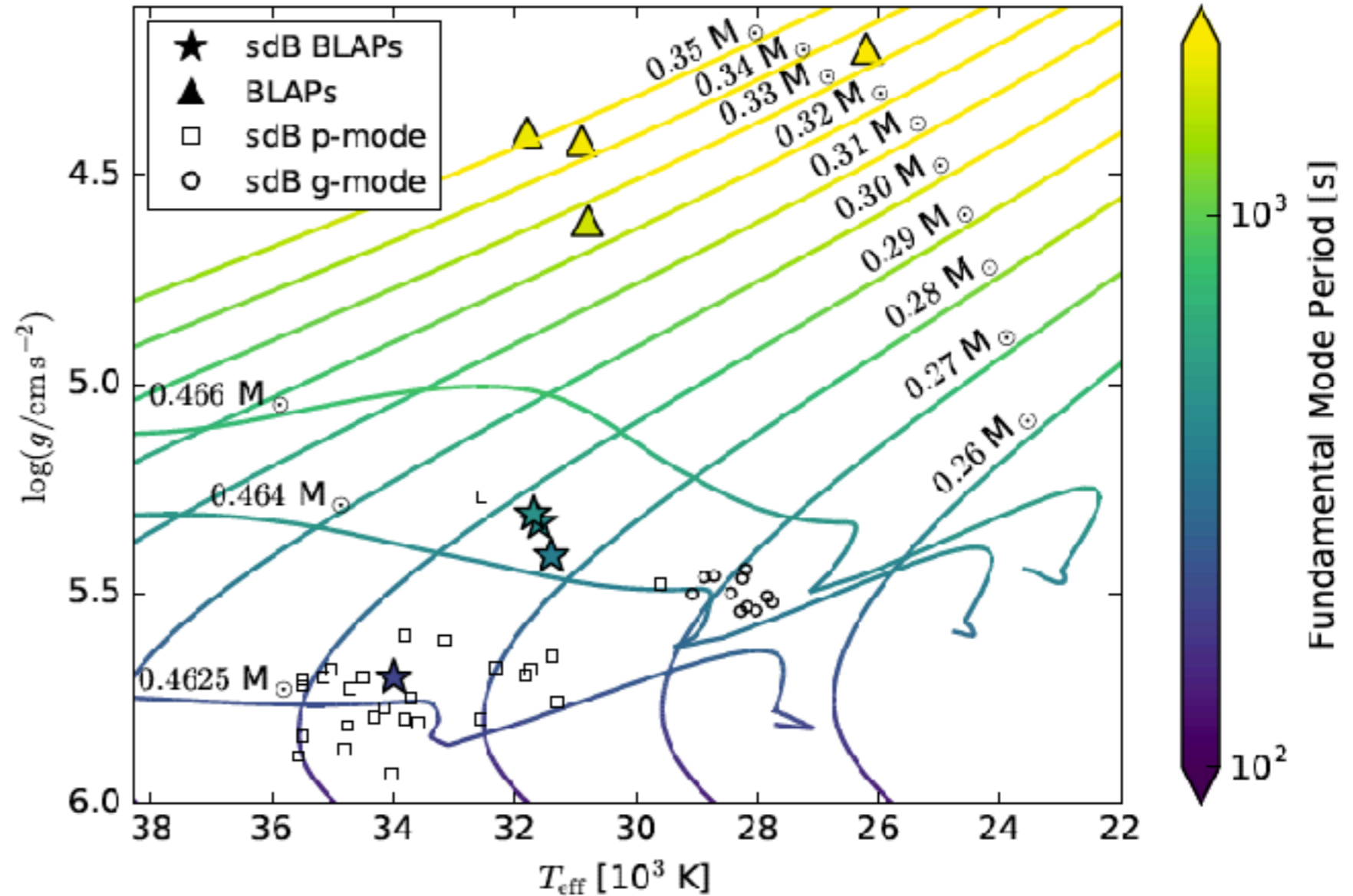
- Large amplitudes (photometry, velocity, Teff, surface gravity)

- 4 candidates, periods 3-8 min

- Observed mass and period is best consistent with cooling low mass helium white dwarf models with mass around 0.25 - 0.30 M_{sun}

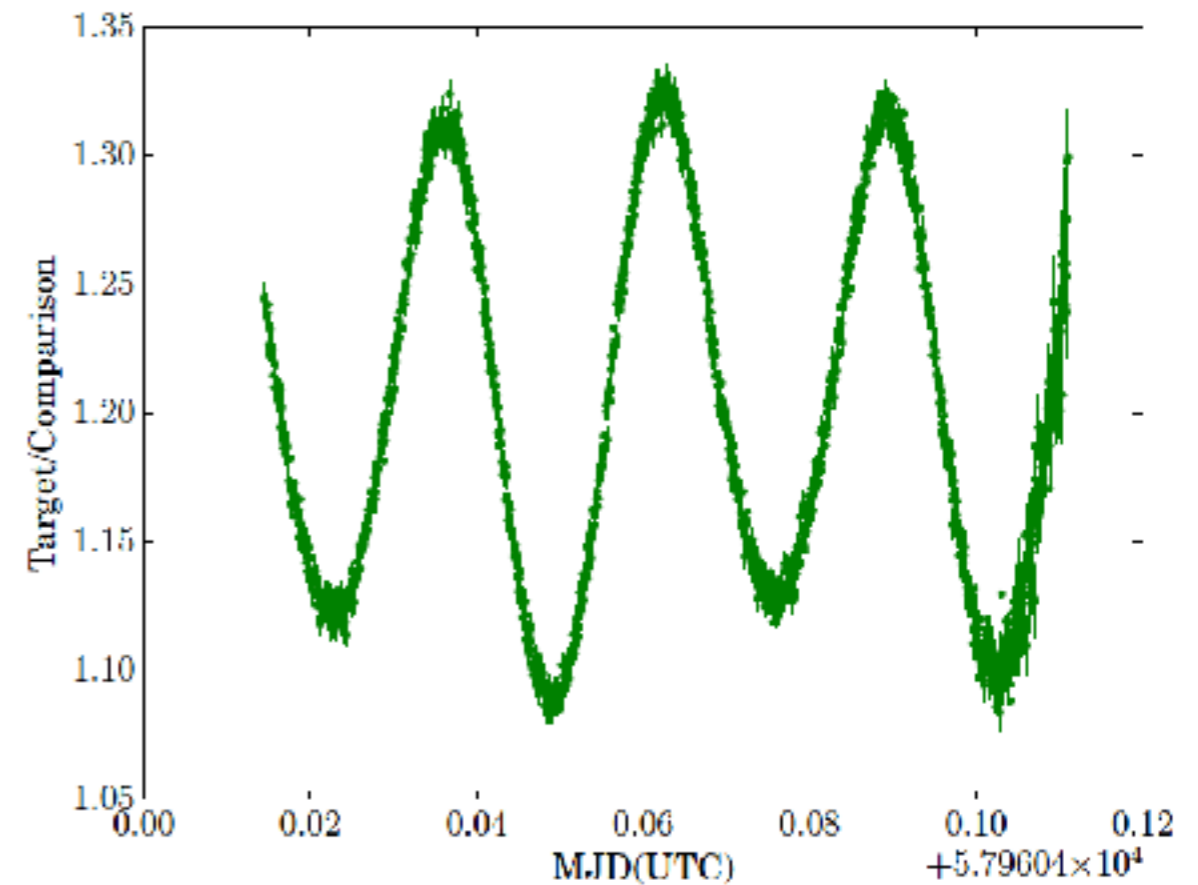- Low mass He-core burning stars cannot be fully excluded

Thomas Kupfer   **Kupfer et al. in prep.**

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Two new CD-30 like systems - Parameter (very preliminary)

PTFS1 J1821 (b=13.9deg)

PTFS1 J2238 (b=8.9deg)

- **P_{orb} = 72.1 min**
- $M_{sdB} \sim 0.40$ M_{sun}
- $M_{WD} \sim 0.65$ M_{sun}

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- $M_{WD} \sim 0.7 - 0.8$ M_{sun}

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Two new CD-30 like systems - Parameter (very preliminary)

ZTFJ0007 (b=-14.6deg)

PTFS1 J182

(b=8.9deg)
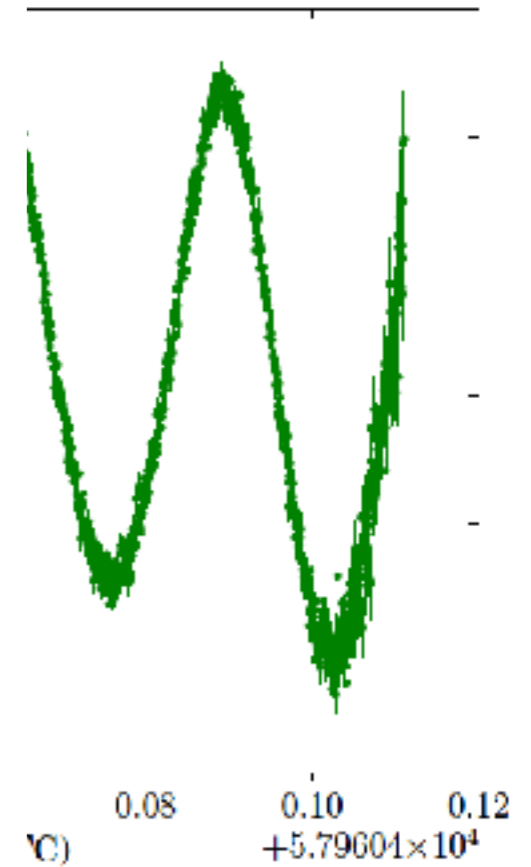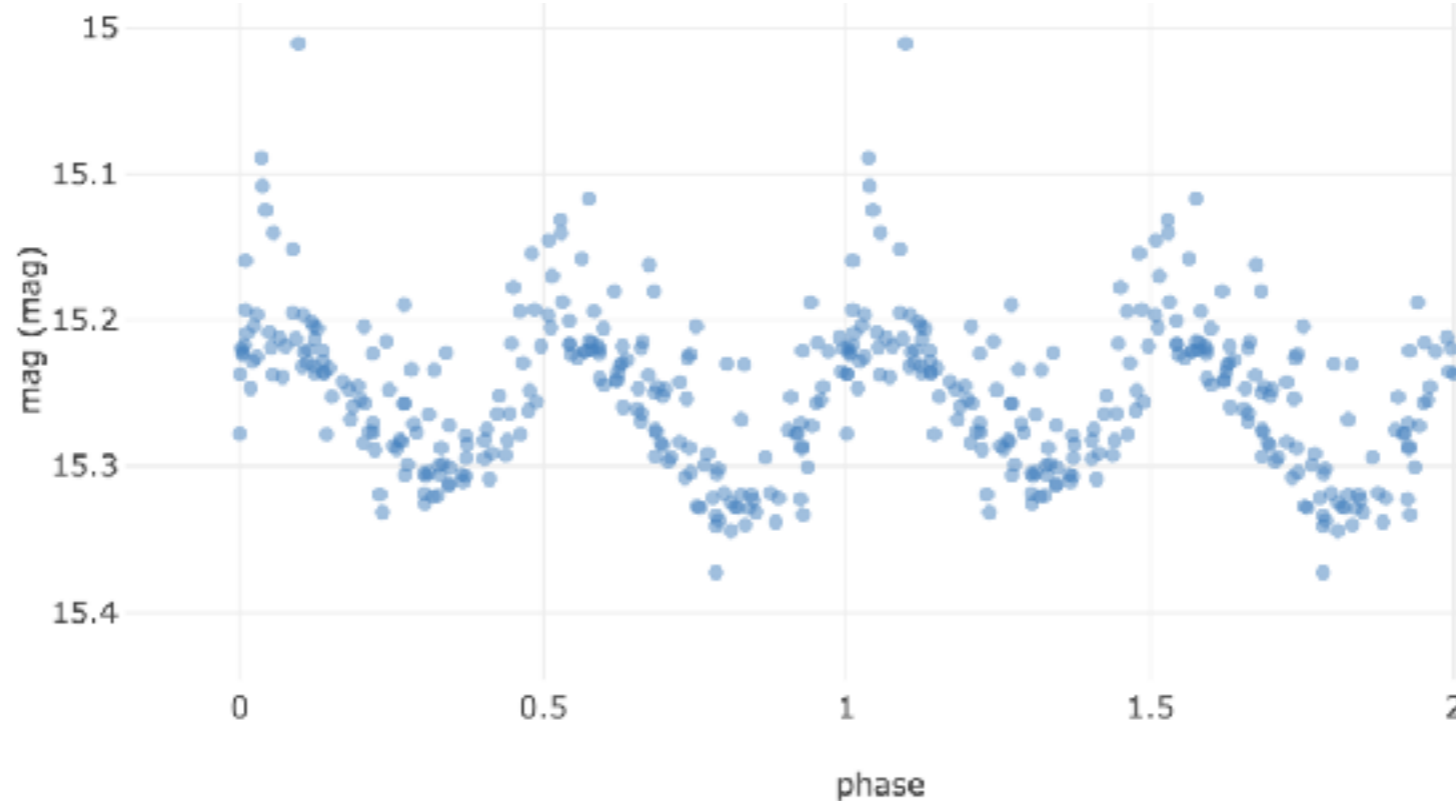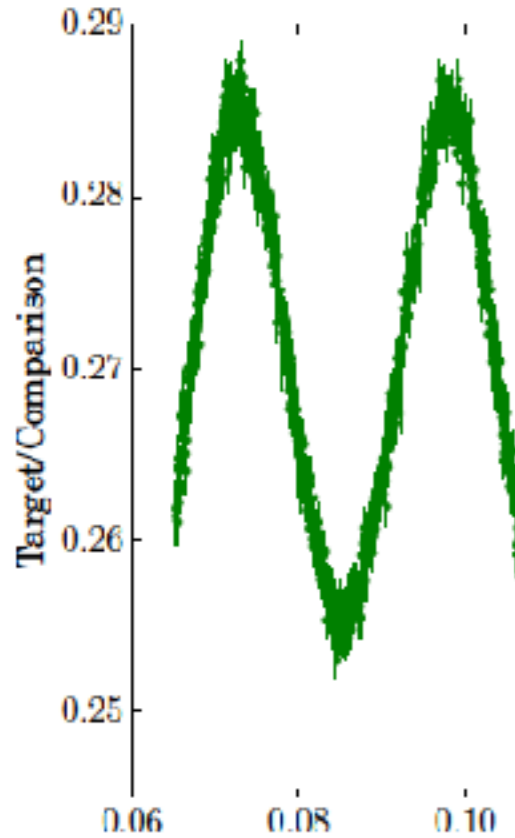
- **P_{orb} = 108 min**
- typical sdB but no full RV curve yet

- **P_{orb} = 72.1**
- M$_{sdB}$ ~ 0.40
- M$_{WD}$ ~ 0.65

4 M$_{sun}$

M$_{sun}$

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ZTF J2130 - The most compact hot subdwarf binary
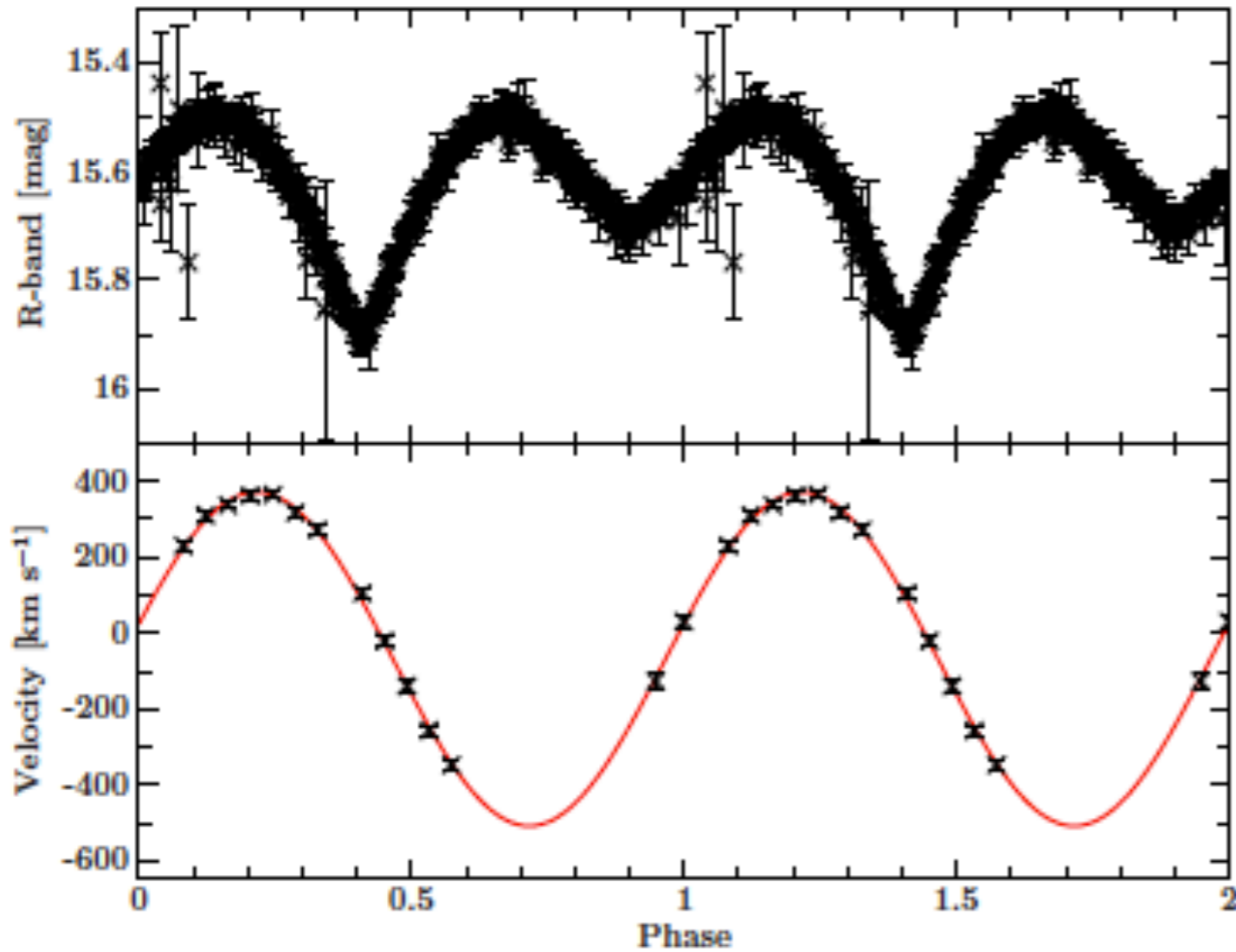
Contact binary
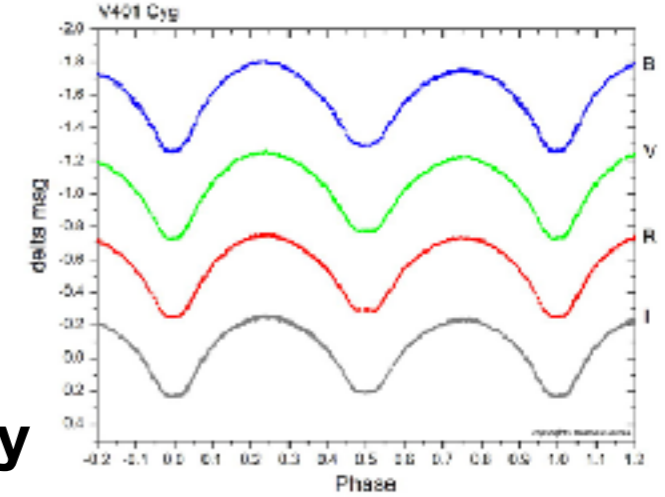
Algol type binary

CV
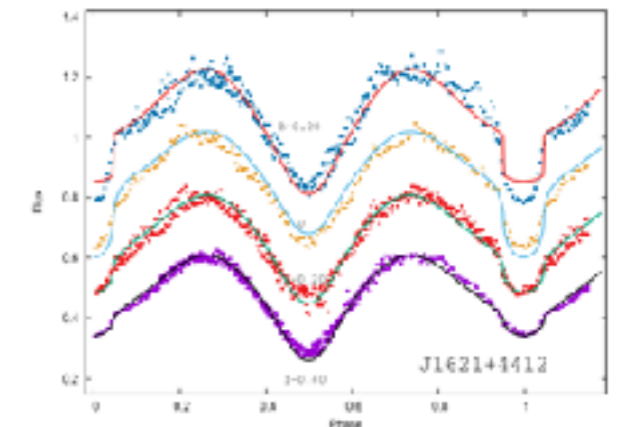
One object stood out

- very short orbital period: 39min
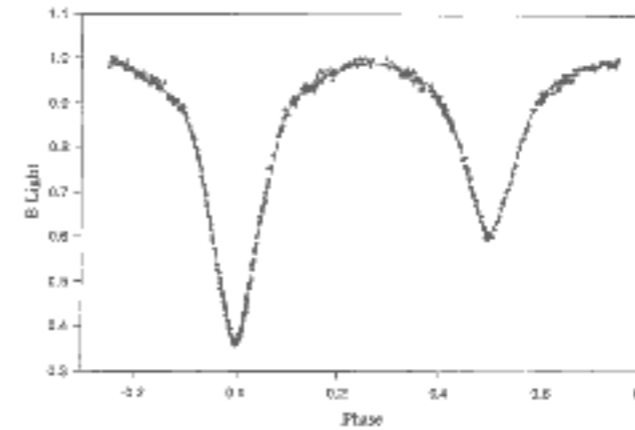
- velocity and phase shows that this is the shortest period hot subdwarf known

- The lightcurve is remarkable and inconsistent with a simple detached ellipsoidal system

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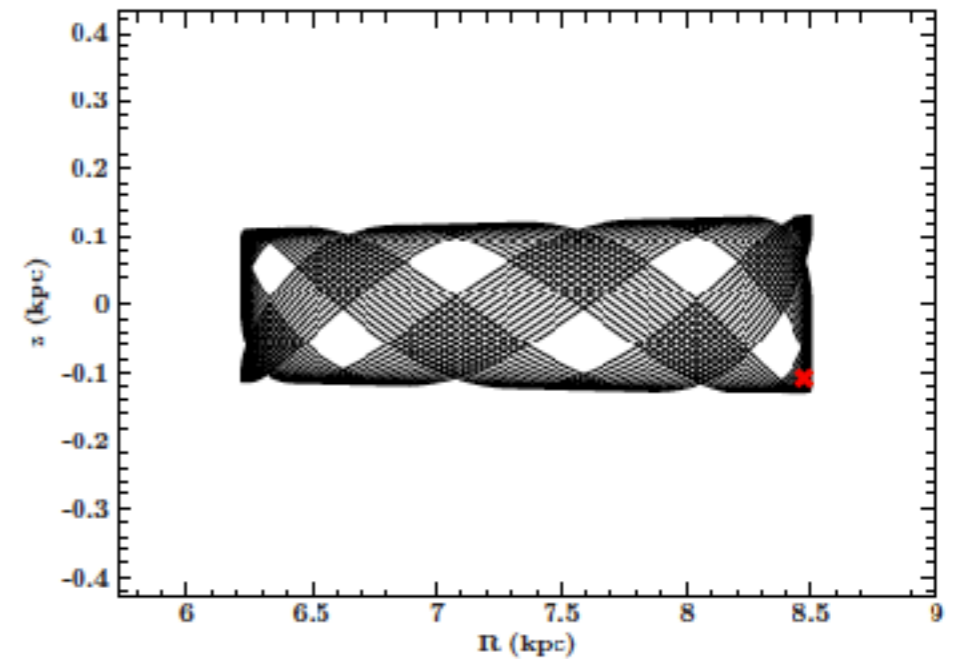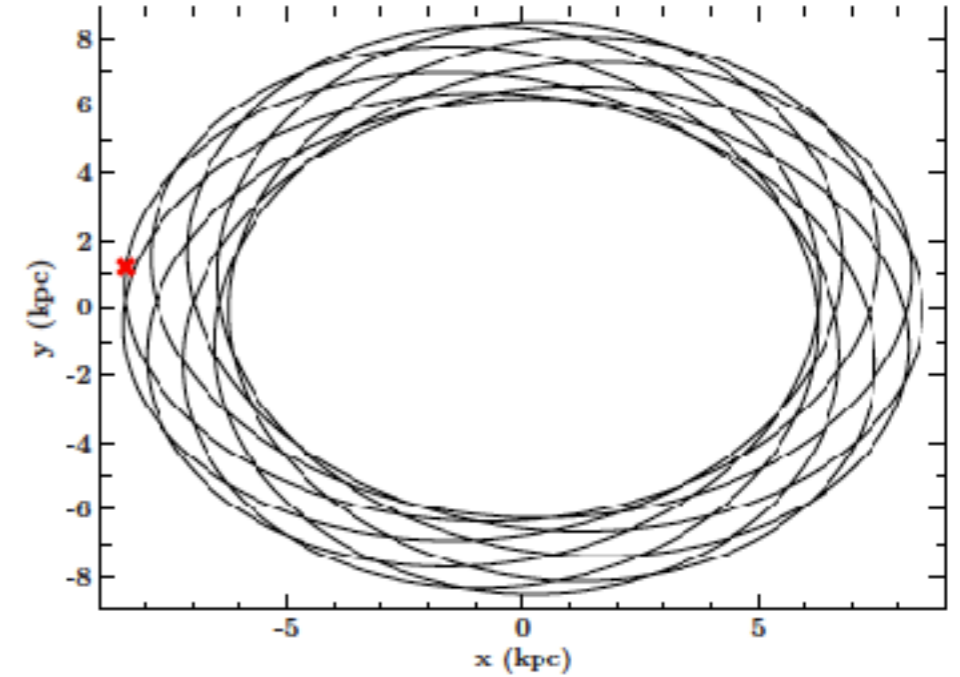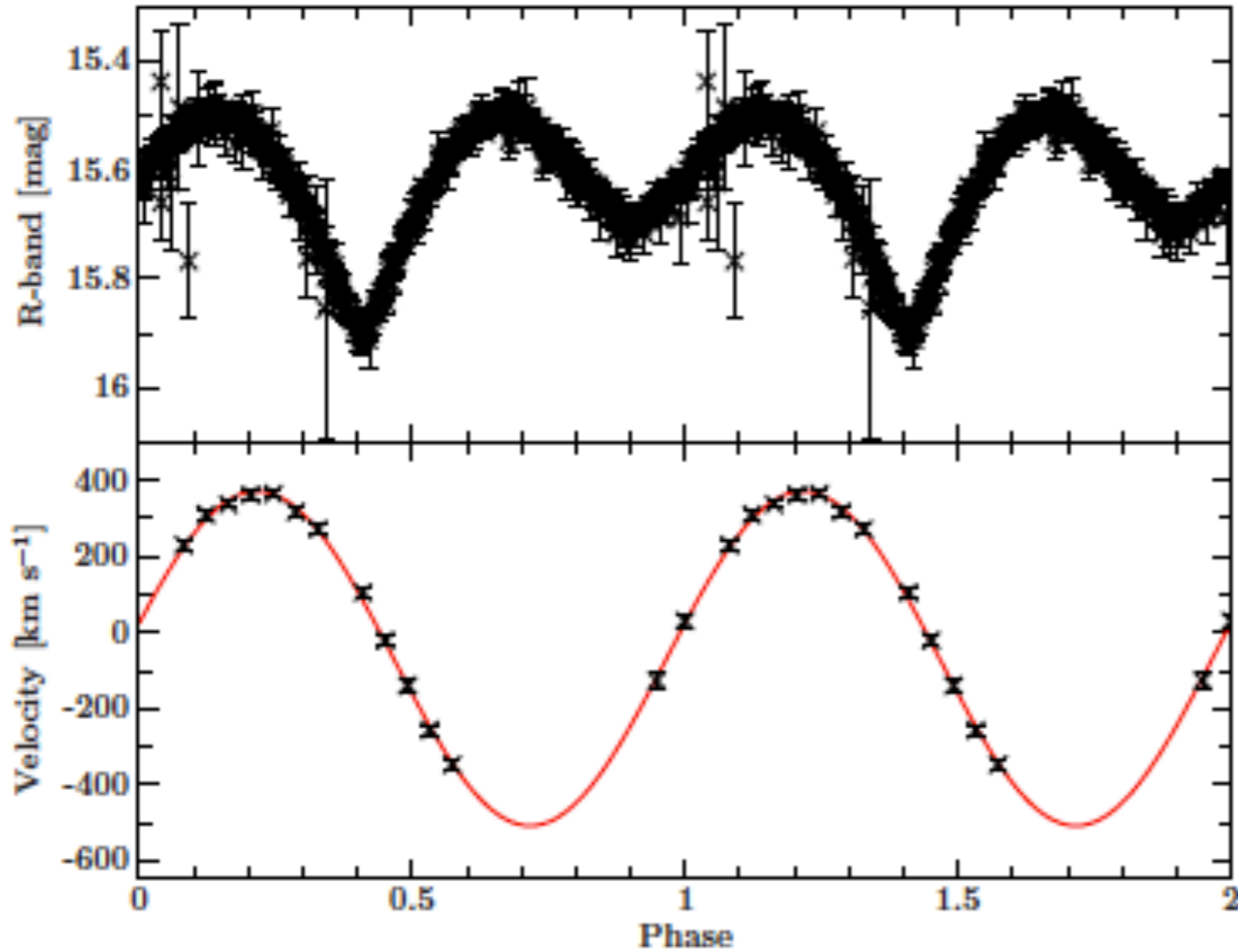
ZTF J2130 - The most compact hot subdwarf binary

One object stood out

- very short orbital period: 39min
- velocity and phase shows that this is the shortest period hot subdwarf known
- The lightcurve is remarkable and inconsistent with a simple detached ellipsoidal system
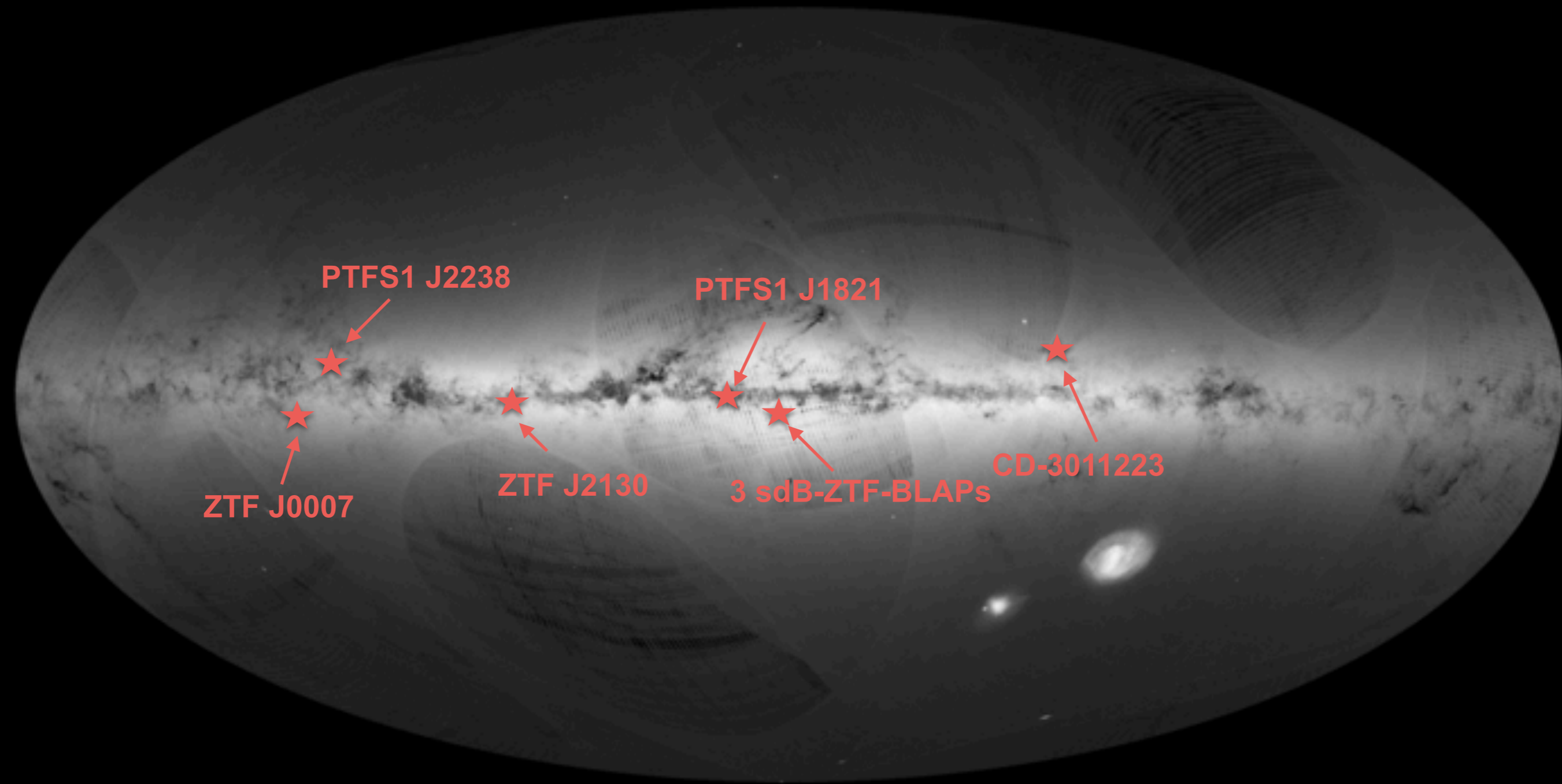- Kinematics shows its a member of the thin disc population

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The sky location of the presented 'exotic' variables

- All systems are located at low Galactic latitudes

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Summary

- 'Exotic' objects can teach us a lot about stellar evolution and stars in general

- Combining many catalogs allow us to select 'exotic' from more 'normal' objects
    - In particular Gaia was a game changer

- Combing with time-domain surveys reveal even more information (e.g. binaries, pulsators)

- Bottleneck now is follow-up (in particular spectroscopy)

- Hot subdwarf catalog has about 1 star per square degree.
    - Perfect filler for multi-object spectrographs
        - **Little price <-> high return**

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