Heartbeat Stars

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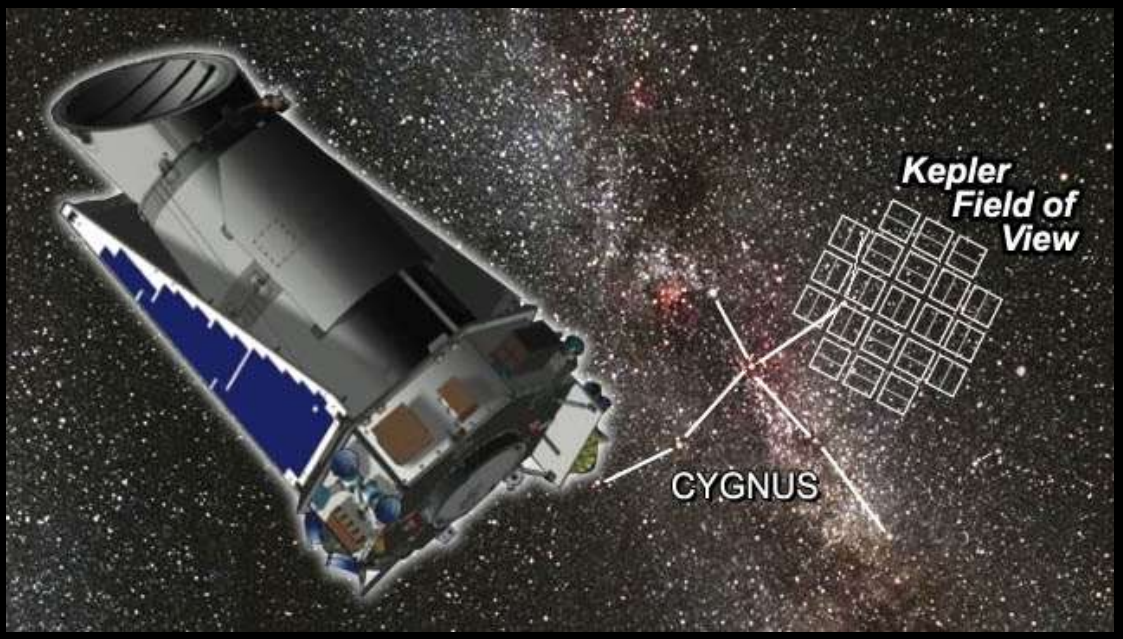
Outline

- The Kepler Mission
- Eccentric binary systems
- Heartbeat stars
- Our results
- The future

The Kepler Satellite

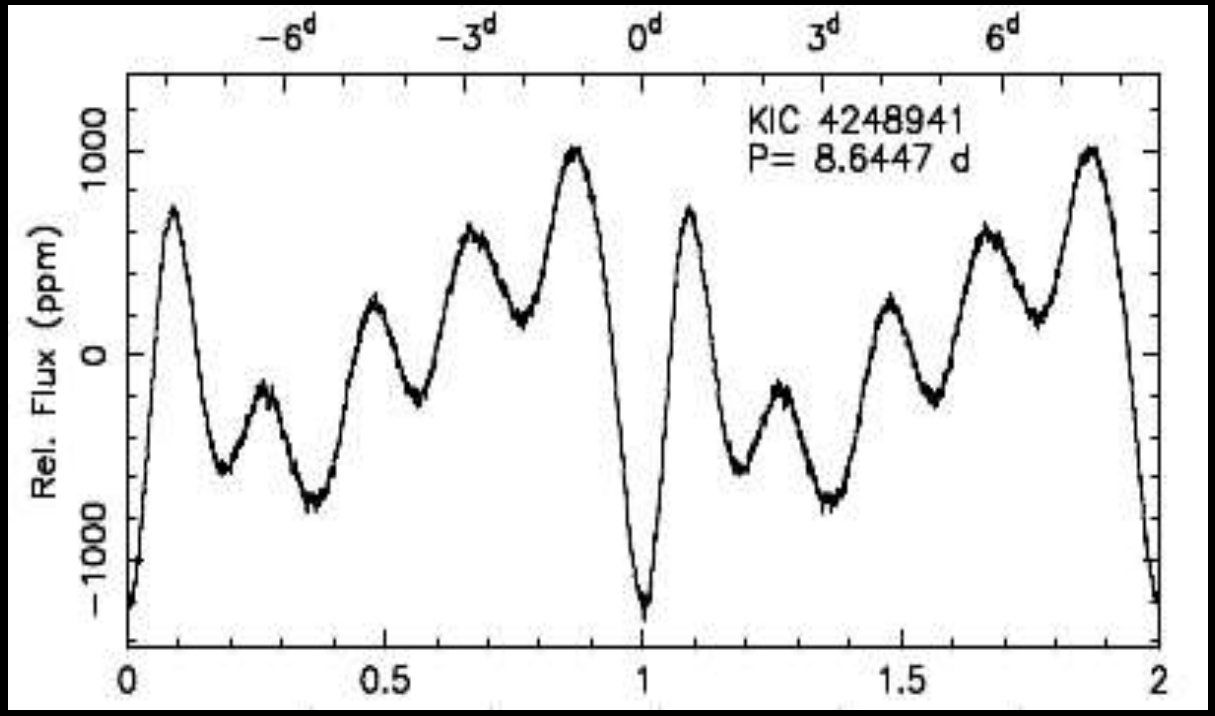


- Launched in 2009
- Looking for variability in over 145,000 stars
- 122 planets confirmed
- 2740 planetary candidates
- 2165 eclipsing binary systems

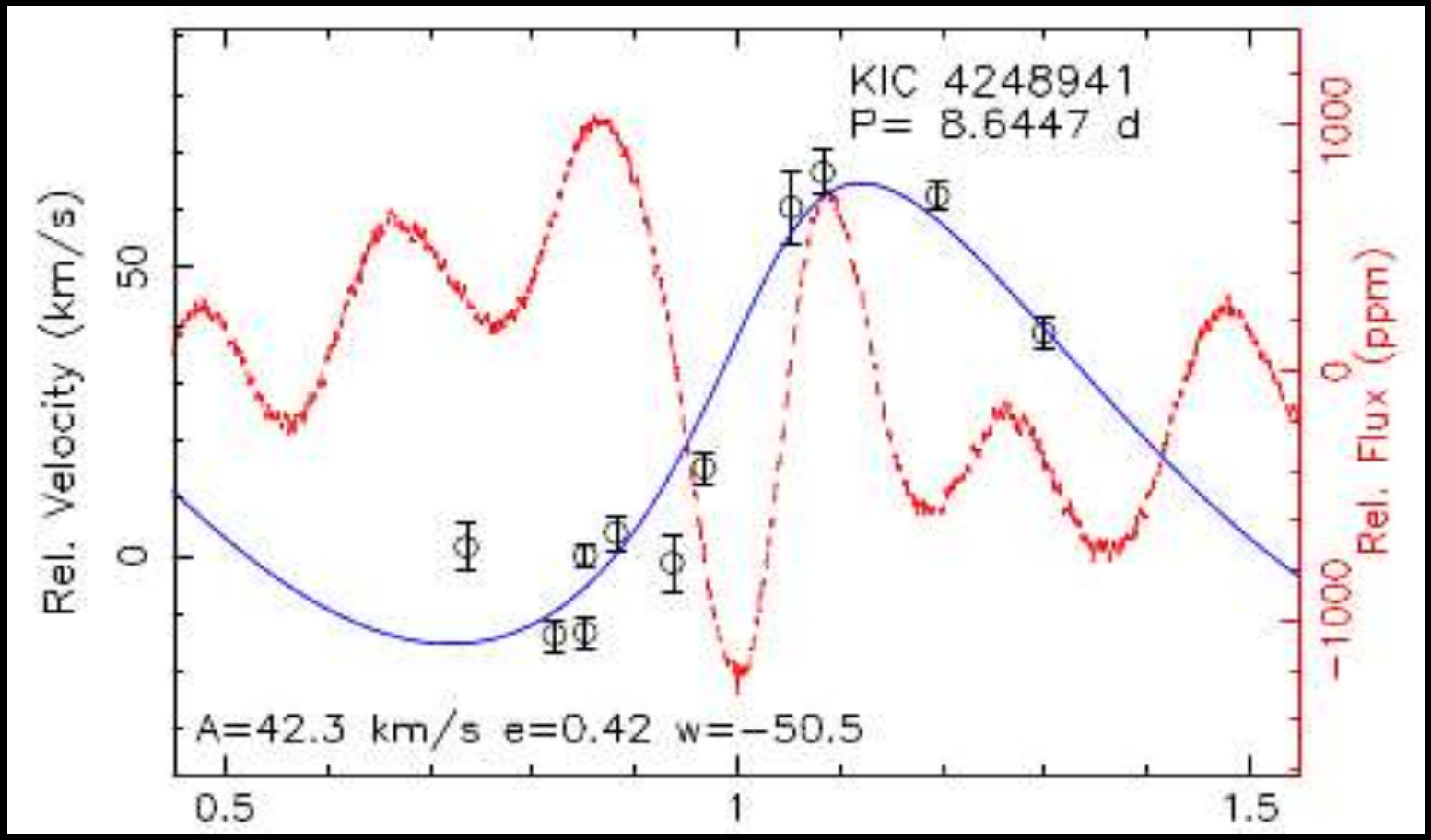
Eccentric Binary Systems

Tidally Induced Distortions

Heartbeat Stars



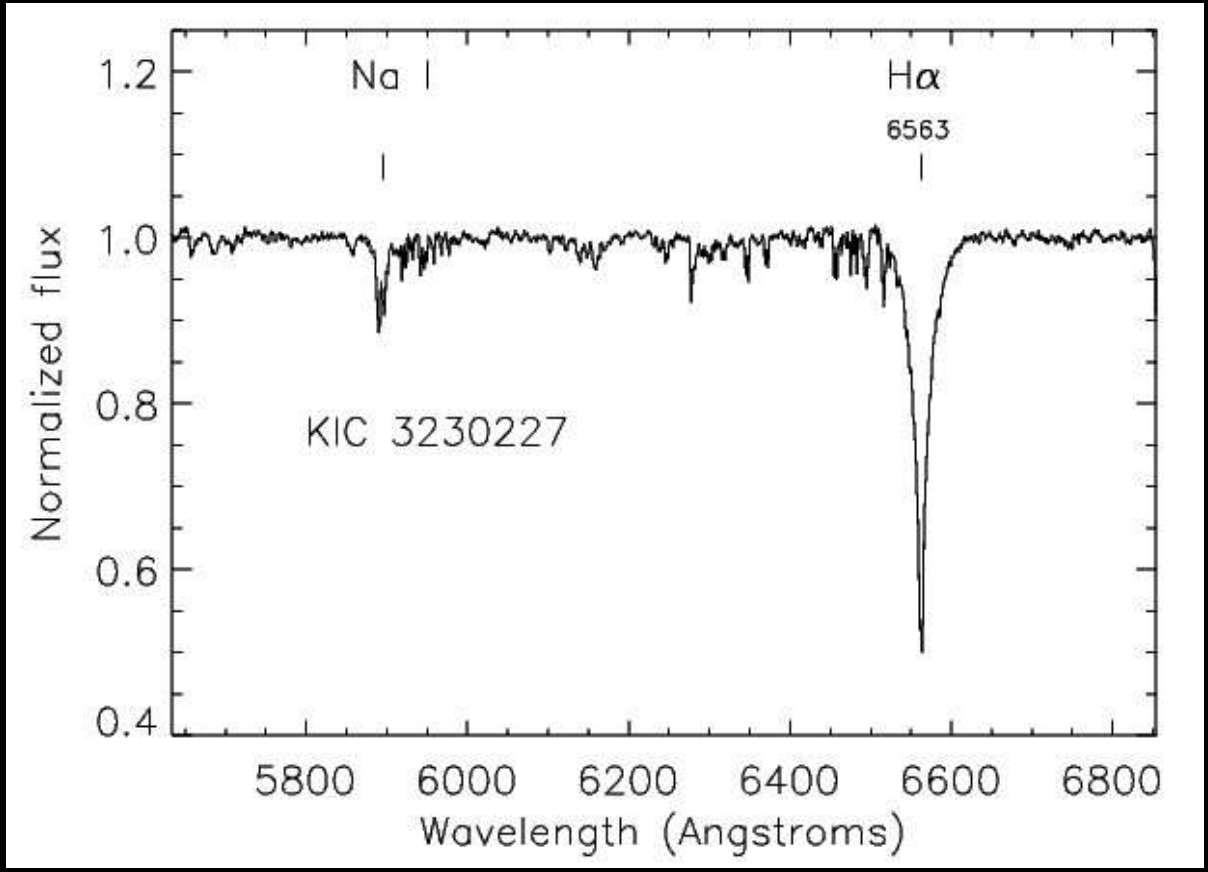
Eccentric binaries with dynamic tidal distortions


KIC 4248941
P= 8.6447 d
Rel. Velocity (km/s)
50
0
1000
0
−1000
Rel. Flux (ppm)
A=42.3 km/s e=0.42 w=−50.5
0.5
1
1.5

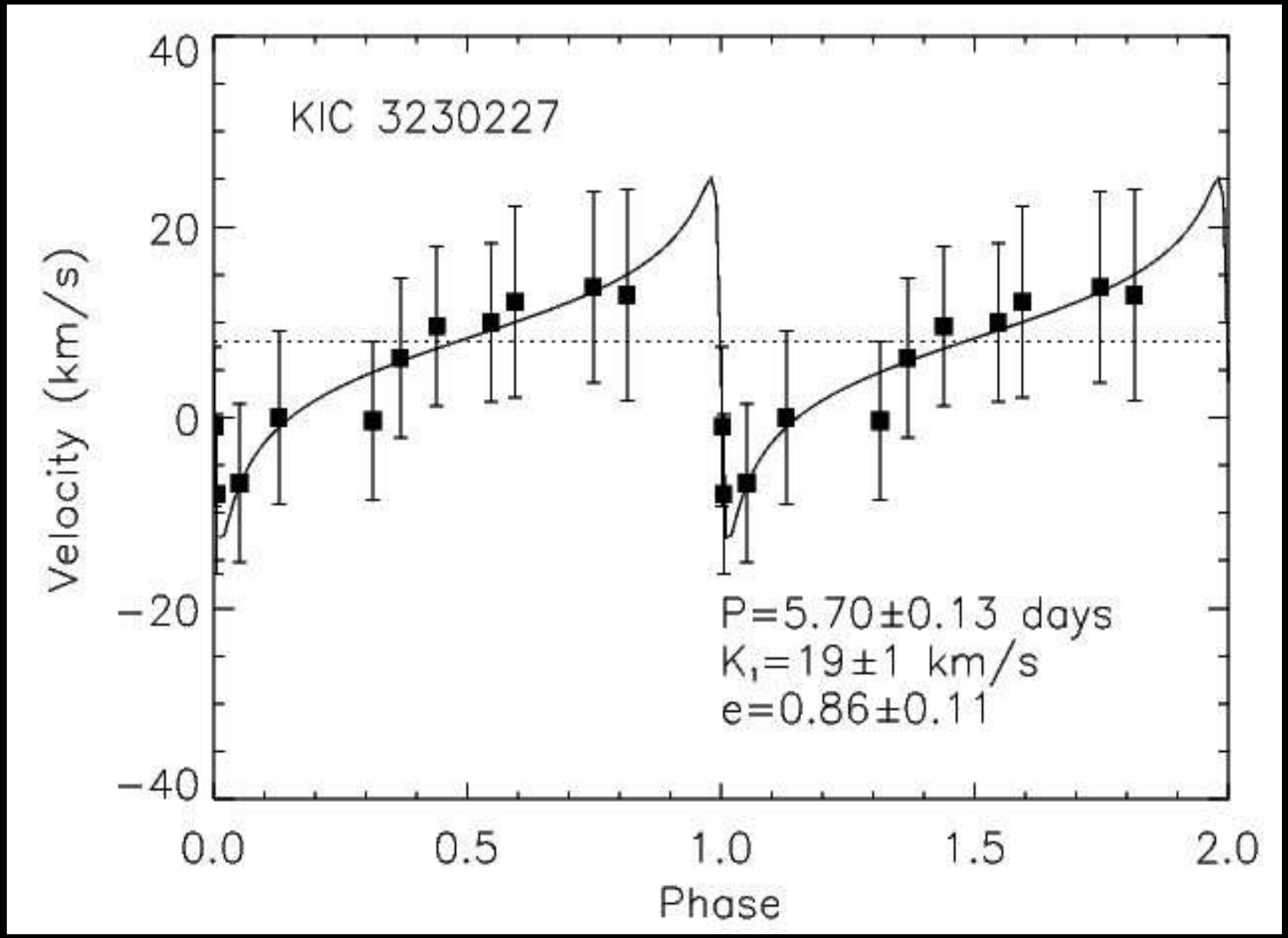
Observations

- 11 nights of data over six months
- 4 stars observed:
  - KIC 3230227
  - KIC 4248941
  - KIC 8719524
  - KIC 11494130

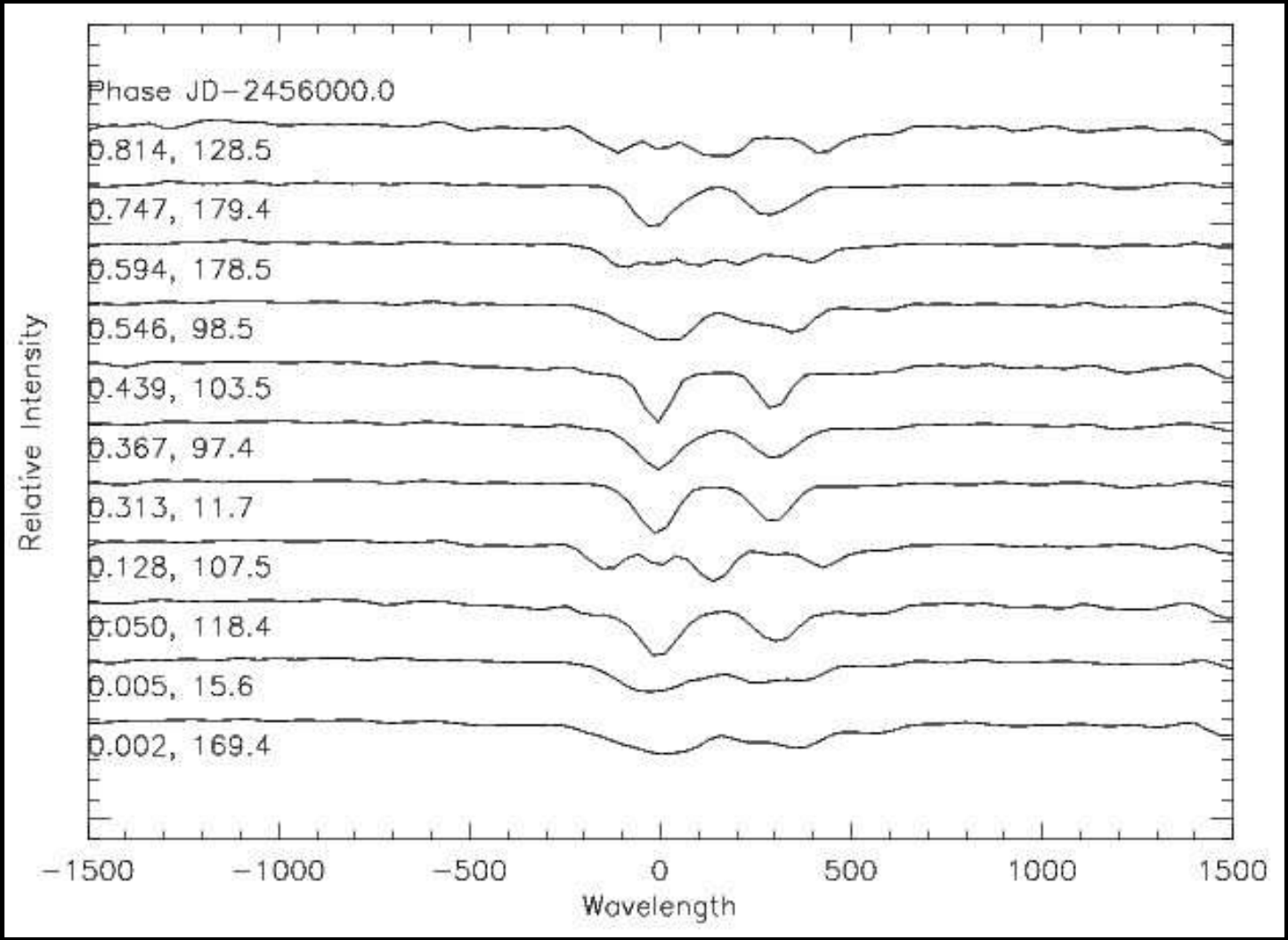
KIC 3230227



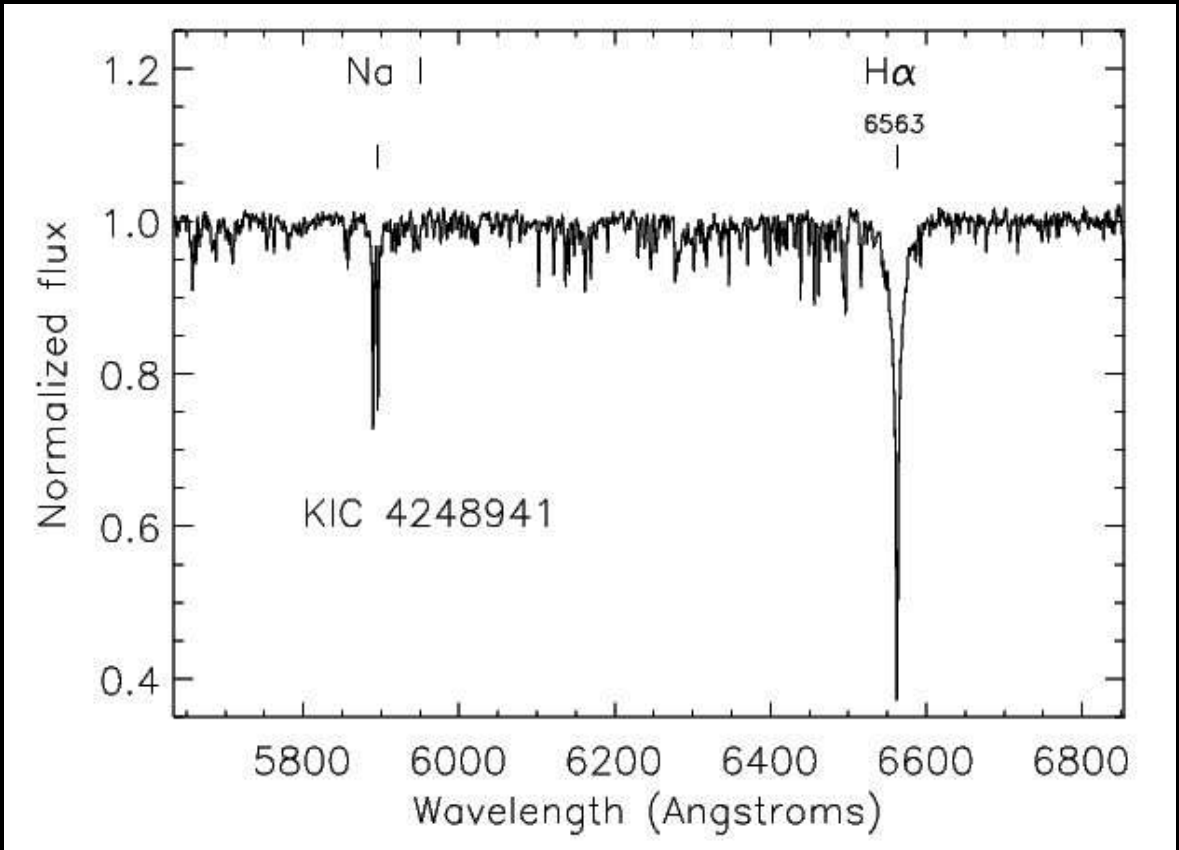
- A4 Star
- Temperature: 8750 K
- Period: 7.047 days
- Eccentricity: 0.588


KIC 3230227
P=5.70±0.13 days
K1=19±1 km/s
e=0.86±0.11
Velocity (km/s)
Phase
40
20
0
−20
−40
0.0
0.5
1.0
1.5
2.0

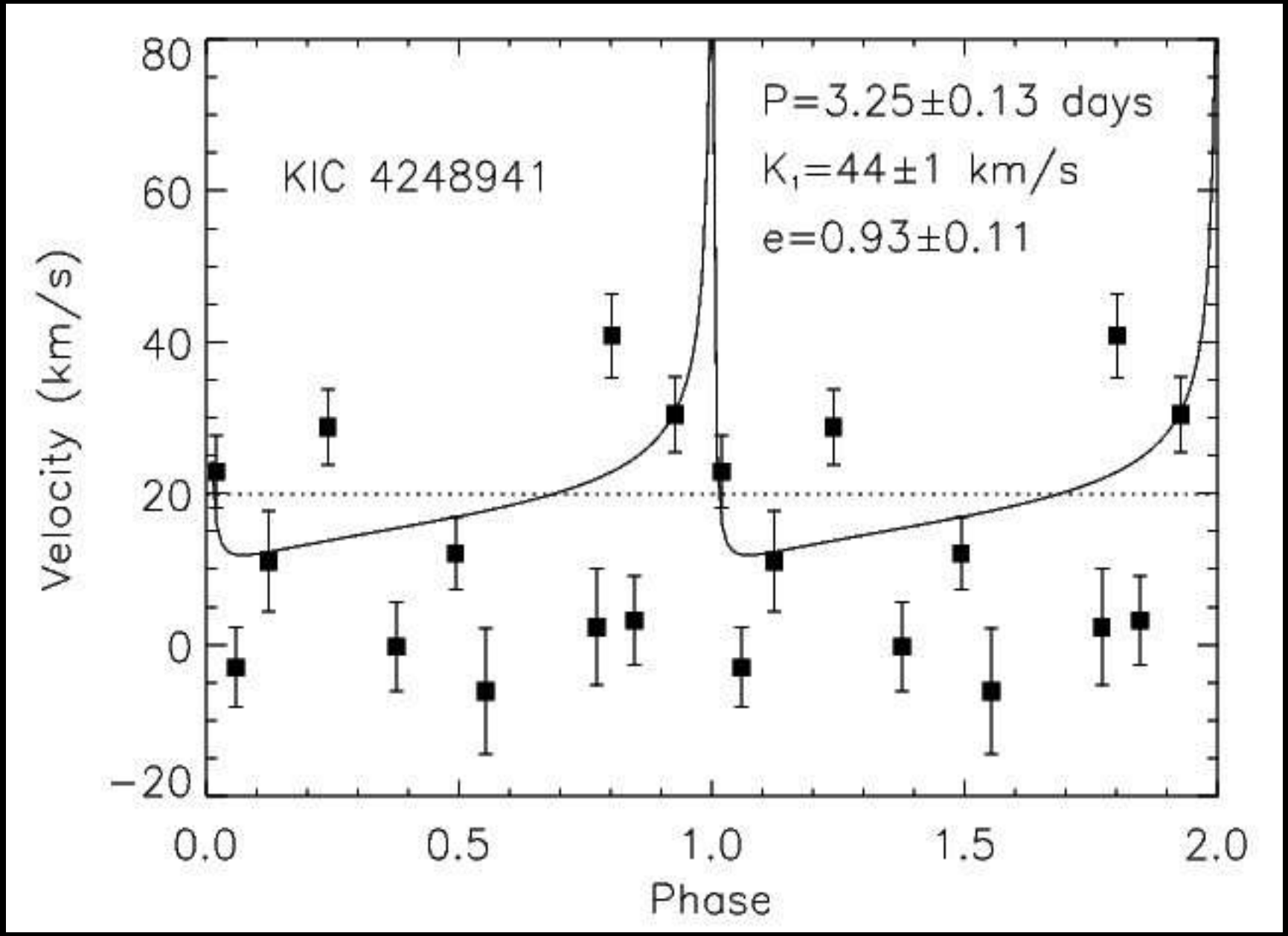
The Sodium Mystery



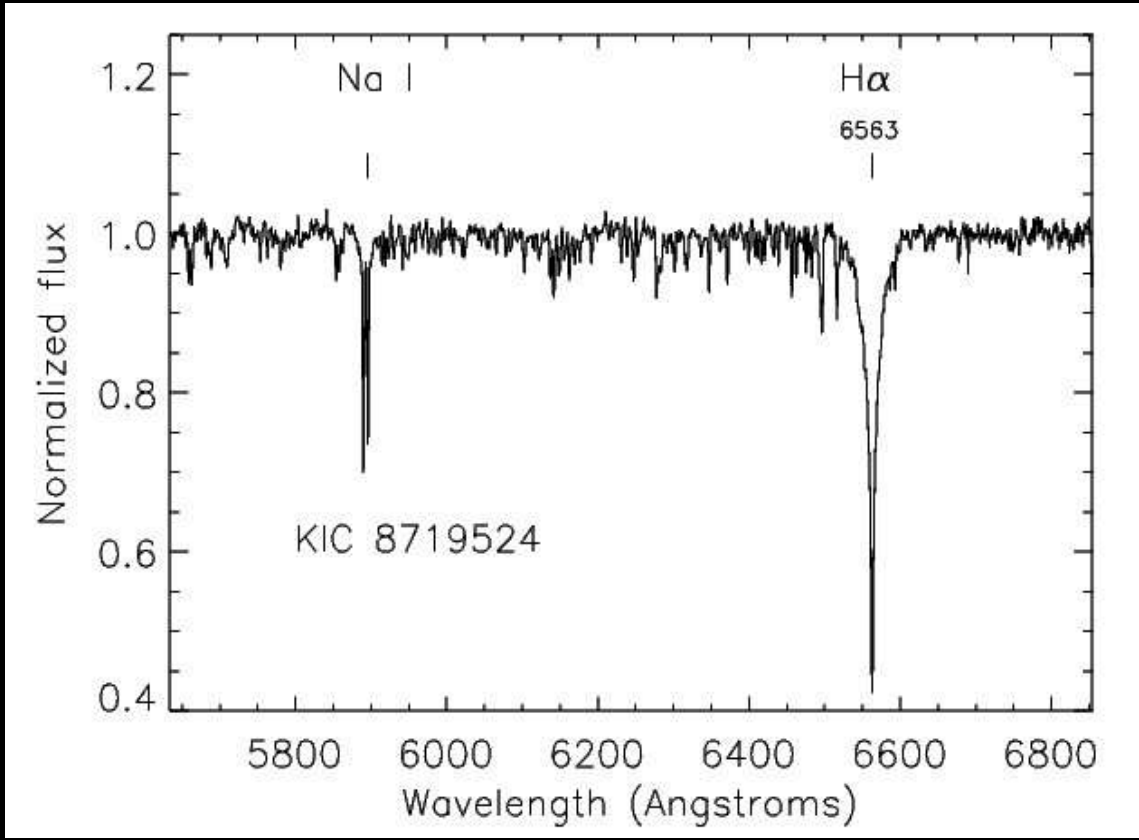
KIC 4248941



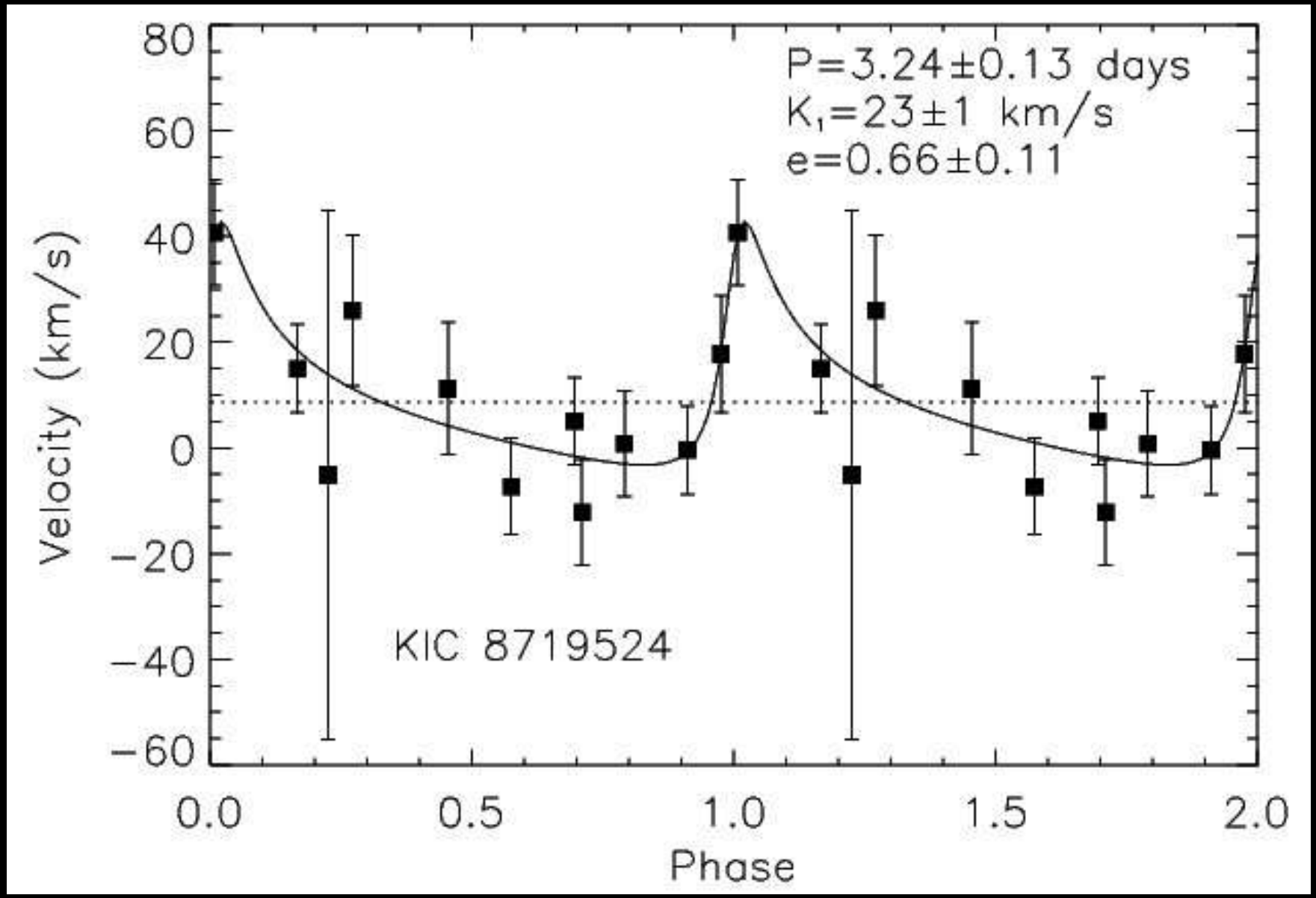
- F3 Star
- Temperature: 6750 K
- Period: 8.645 days
- Eccentricity: 0.423


KIC 4248941
P=3.25±0.13 days
K1=44±1 km/s
e=0.93±0.11
Velocity (km/s)
Phase
80
60
40
20
0
−20
0.0
0.5
1.0
1.5
2.0

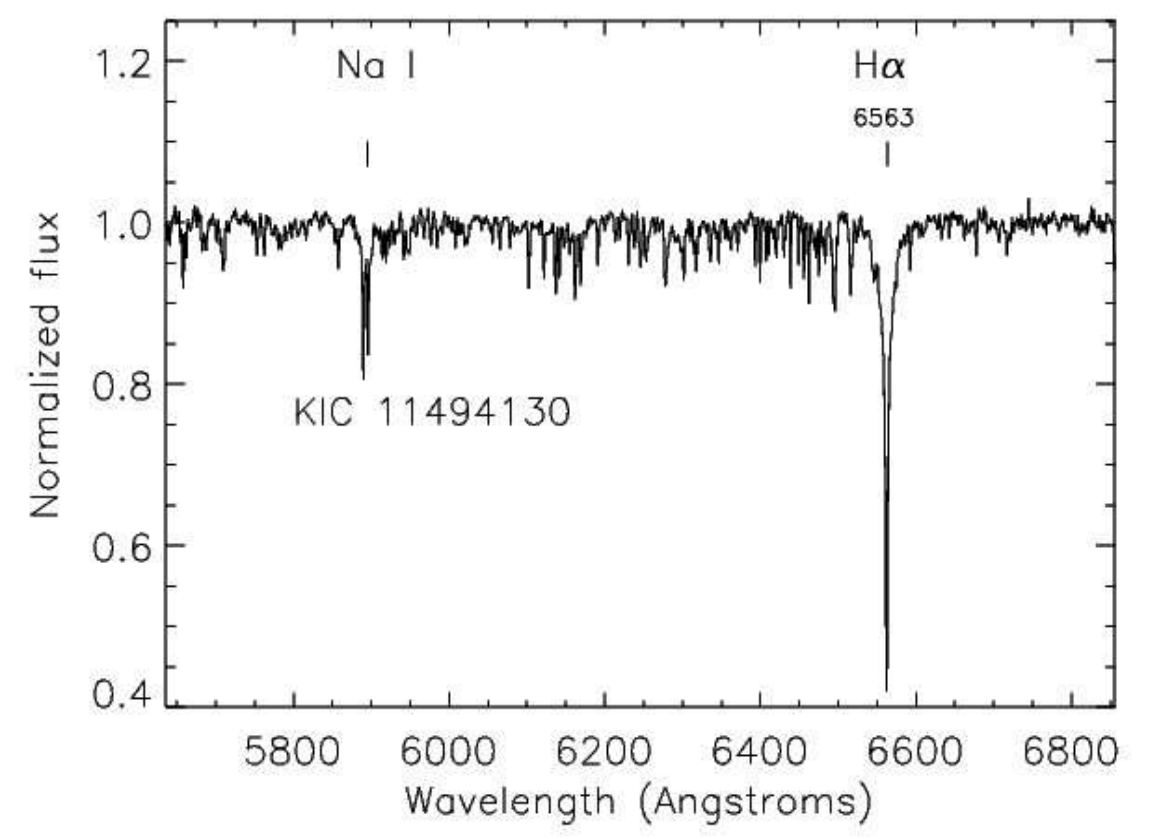
KIC 8719524



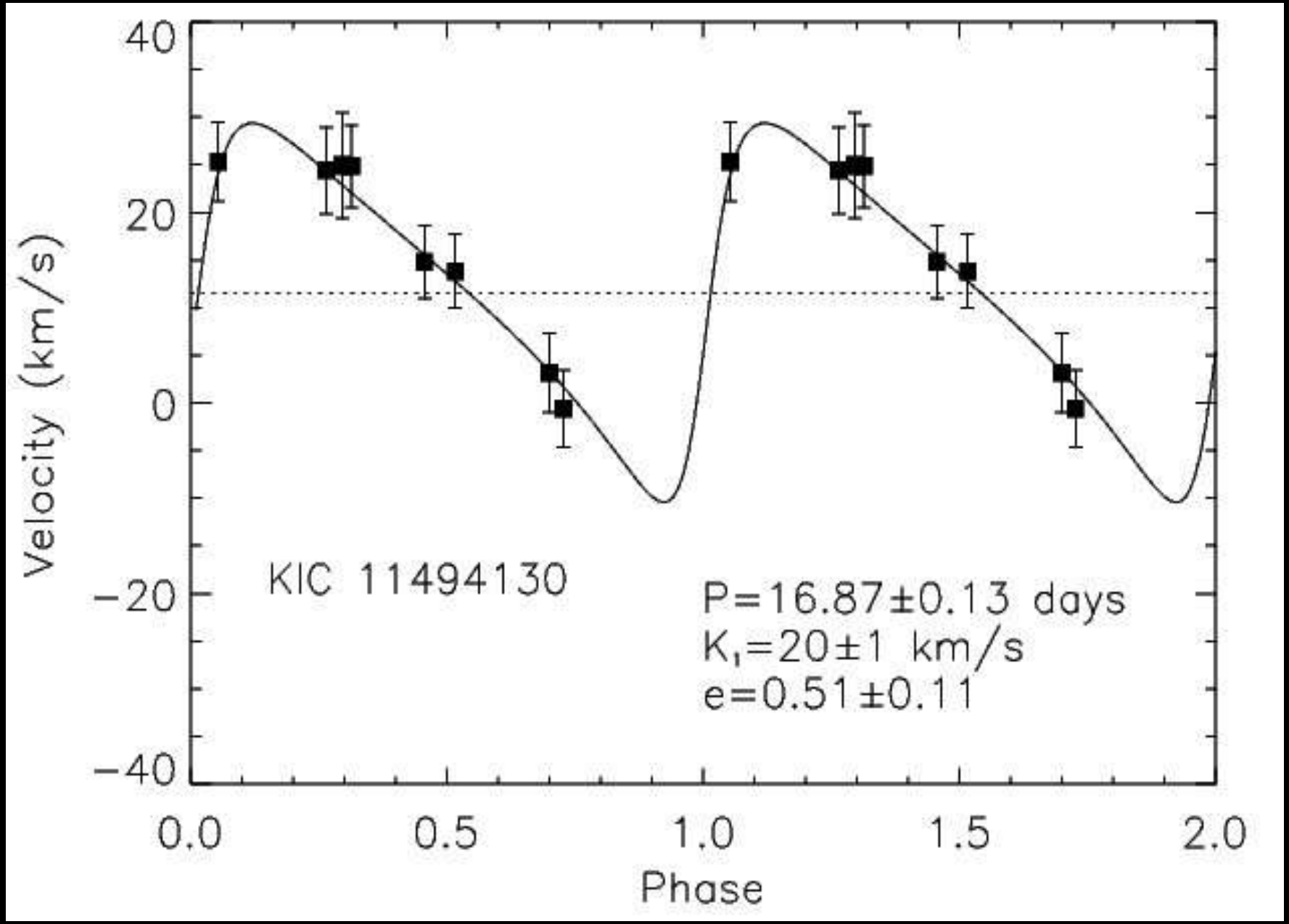
- A9 Star
- Temperature: 7750 K
- Period: 10.233 days
- Eccentricity: 0.600


P=3.24±0.13 days
K1=23±1 km/s
e=0.66±0.11
KIC 8719524
Velocity (km/s)
Phase
80
60
40
20
0
−20
−40
−60
0.0
0.5
1.0
1.5
2.0

KIC 11494130



- F3 Star
- Temperature: 6750 K
- Period: 18.956 days
- Eccentricity: 0.618


40
20
0
−20
−40
Velocity (km/s)
0.0
0.5
1.0
1.5
2.0
Phase
KIC 11494130
P=16.87±0.13 days
K1=20±1 km/s
e=0.51±0.11

The Future

- We will continue observing these targets and add more to our sample
- This should allow us to determine some of the unique characteristics of the system
  - Better understand distortions and pulsations
- We may also be better able to predict the formation scenarios for this type of system
- We will better understand stellar evolution