

Asteroseismology of KIC 7107778: a binary comprising almost identical subgiants

Miles Lucas

Department of Physics and Astronomy
Iowa State University

April 4, 2018

Introduction

Binary systems provide a good laboratory for studying stellar evolution due to their convenient constraints on metal abundance and age. Asteroseismology allows new ways to study binaries that previously could not due to being unresolved or non-eclipsing. The study of KIC 7107778 by Li and Bedding will show the power of asteroseismology in a very unique binary system.

Conclusions

1. KIC 7107778 is comprised of two subgiant stars with overlapping, solar-like power spectra

Conclusions

1. KIC 7107778 is comprised of two subgiant stars with overlapping, solar-like power spectra
2. The estimated stellar parameters of these stars show that they are nearly identical

KIC 7107778

Interesting features of this binary system

- ▶ Solar like oscillations from both components
- ▶ Unresolved
- ▶ Non-eclipsing
- ▶ Widely separated

Preliminary Data

Separation from *GAIA* parallax

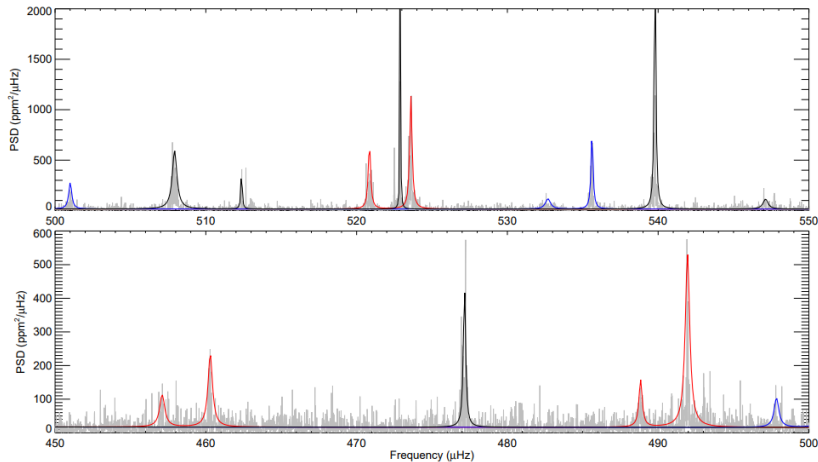
- ▶ $s = 16.52 \pm 4.35$ AU

Temperature and metallicity from Xiang et al. (2015)

- ▶ $T_{\text{eff}} = 5149 \pm 150$ K
- ▶ $[Fe/H] = 0.11 \pm 0.10$ dex

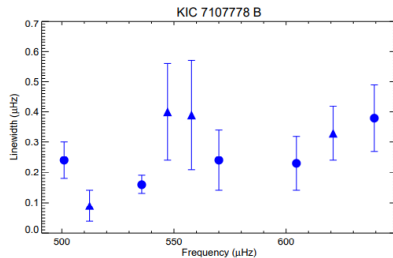
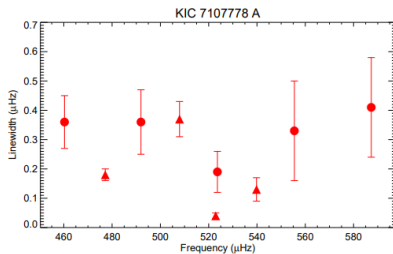
Power spectrum from *Kepler* short-cadence mode

The Spectrum



Black lines are fit mixed modes ($l = 1$). Red are star A $l = 0, 2$ modes. Blue are star B $l = 0, 2$ modes.

Modes



Circles represent $l = 0$ and triangles represent $l = 1$

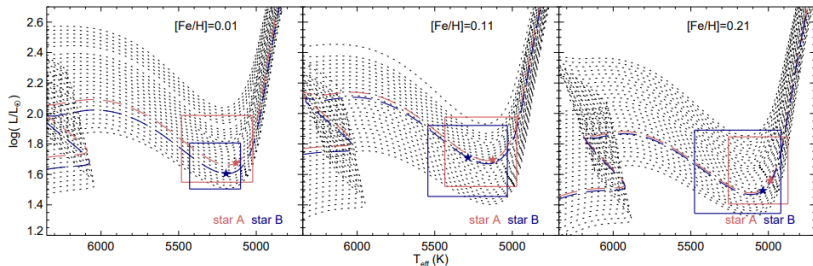
Asteroseismic Analysis

Non-eclipsing; must estimate stellar parameters from power spectrum

$$\frac{M}{M_{\odot}} \approx \left(\frac{\Delta\nu}{\Delta\nu_{\odot}} \right)^{-4} \left(\frac{\nu_{max}}{\nu_{max,\odot}} \right)^3 \left(\frac{T_{eff}}{T_{eff,\odot}} \right)^{3/2}$$

This helps constrain *MESA* modeling given the power spectra

MESA Models, $I = 0, 2$



Star	$[\text{Fe}/\text{H}]$ [dex]	M [M_{\odot}]	Age [Gyr]	T_{eff} [K]	L [L_{\odot}]	R [R_{\odot}]	$\log g$ [dex]	Δv [μHz]	v_{max} [μHz]
A	0.01	1.41 ± 0.06	3.178 ± 0.440	5216 ± 258	5.813 ± 1.508	2.925 ± 0.047	3.654 ± 0.005	32.01 ± 0.18	534 ± 8
B	0.01	1.38 ± 0.03	3.289 ± 0.263	5233 ± 132	5.140 ± 0.692	2.754 ± 0.025	3.699 ± 0.003	34.77 ± 0.13	592 ± 5
A	0.11	1.43 ± 0.07	3.266 ± 0.583	5184 ± 290	5.787 ± 1.663	2.945 ± 0.055	3.656 ± 0.007	31.98 ± 0.17	539 ± 9
B	0.11	1.38 ± 0.03	3.606 ± 0.313	5092 ± 105	4.594 ± 0.549	2.751 ± 0.025	3.700 ± 0.004	34.81 ± 0.12	601 ± 4
A	0.21	1.41 ± 0.07	3.643 ± 0.551	5037 ± 199	5.032 ± 1.160	2.926 ± 0.054	3.655 ± 0.006	32.06 ± 0.15	546 ± 6
B	0.21	1.40 ± 0.04	3.657 ± 0.317	5045 ± 106	4.473 ± 0.535	2.765 ± 0.028	3.701 ± 0.003	34.78 ± 0.13	606 ± 4

MESA Models, $I = 1$

Mixed modes extremely sensitive to mass. Use bisection method to determine mass up to $0.001 M_{\odot}$

NO. #	Star	M [M_{\odot}]	[Fe/H] [dex]	Age [Gyr]	T_{eff} [K]	L [L_{\odot}]	R [R_{\odot}]	$\log g$ [dex]	$M_{H,\text{core}}$ [M_{\odot}]	Δv [μHz]	v_{max} [μHz]
1	A	1.41	0.01	3.063	5130	5.342	2.929	3.655	0.165	32.04	540
2	B	1.39	0.01	3.229	5195	4.982	2.759	3.699	0.157	34.74	594
3	A	1.48	0.11	2.873	5120	5.464	2.975	3.661	0.170	32.00	548
4	B	1.47	0.11	2.929	5267	5.478	2.814	3.705	0.162	34.64	599
5	A	1.42	0.21	3.533	4987	4.763	2.927	3.656	0.165	32.10	549
6	B	1.41	0.21	3.548	5038	4.443	2.770	3.703	0.160	34.80	608

Conclusions

1. KIC 7107778 is comprised of two subgiant stars with overlapping, solar-like power spectra
2. The estimated stellar parameters of these stars show that they are nearly identical
 - ▶ $M_A = 1.42 \pm 0.06 M_{\odot}$, $M_B = 1.39 \pm 0.03 M_{\odot}$
 - ▶ $R_A = 2.93 \pm 0.05 R_{\odot}$, $R_B = 2.76 \pm 0.04 R_{\odot}$
 - ▶ $t_A = 3.32 \pm 0.54 \text{ Gyr}$, $t_B = 3.51 \pm 0.33 \text{ Gyr}$