

Science Review: Recent Results at the CHARA Array



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The CHARA Array of Georgia State University

Mount Wilson, CA









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- Stellar Astrophysics
 - Stellar Diameters
 - Rapid Rotation
 - Spotted Stars
- Binary Stars
 - Orbits
 - High Contrast Binaries
 - Interacting Binaries

- Circumstellar Disks
 - Be Stars
 - Young Stellar Objects
- Transient Events
 - Nova Explosions















CHARA Community Workshop 2017-03-15

Interferometric Observables



- Visibility amplitude
 - size and structure of source



















Interferometric Observables



Monnier 2007

- Visibility amplitude
 - size and structure of source
- Closure phase
 - asymmetries in source distribution







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Interferometric Observables

- Visibility amplitude
 - size and structure of source
- Closure phase
 - asymmetries in source distribution
- Differential visibilities and phases
 - emission lines
 - velocity structure



















- Angular diameter + parallax
 - Linear radius





















Observatoire

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- Angular diameter + parallax
 - Linear radius
- Spectral Energy Distribution
 - Bolometric flux

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Observatoire

- Angular diameter + parallax
 - Linear radius
- Spectral Energy Distribution
 - Bolometric flux
- Effective Temperature
 - $F_{bol} = \frac{1}{4} \theta^2 \sigma T^4$

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Exoplanet Host Stars



- Physical parameters of planets
 - Mass, age
- Size of habitable zones















 $<v_{nl}>$: frequency separation of modes

 ν_{max} : frequency of maximum power

















 v_{max} : frequency of maximum power











Huber et al. (2012)



Observatoire de la COTE d'AZUR



• Radial velocity and angular diameter variation of delta Cephei measured over the pulsational phase (Merand et al. 2005)

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• Improve calibration of Baade-Wesselink for determining pulsation parallaxes

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- Oblateness
- Gravity darkening

-
$$T_{eff} \sim g^{\beta}$$



















- Oblateness
- Gravity darkening
 - $~T_{eff} \sim g^{\beta}$
 - von Zeipel model: $\beta = 0.25$
 - empirically derived $\beta = 0.19$



Spotted Stars



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- Magnetically active star zeta Andromedae
- Tidally locked close binary: • RS CVn, K1 III + K1 V
- Rotation Period: 18 days

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Spotted Stars



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- Magnetically active star zeta Andromedae
- Tidally locked close binary: RS CVn, K1 III + K1 V
- Rotation Period: 18 days
- $\theta = 2.502 \pm 0.008$ mas
- Direct confirmation of persistent polar spot

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Observatoire













Schaefer et al. 2016

MAa = 16.99 ± 0.20 M_☉ $MAb = 12.81 \pm 0.18 M_{\odot}$ $d = 387.5 \pm 1.3 \text{ pc}$

- Dynamical masses for 3 O-stars
- Distance to sigma Orionis cluster
- Inner and outer orbits are not coplanar (120 – 127 deg)

















Observatoire

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Kloppenborg et al. (2015)

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Binary orbit + ellipsoidal variations

Roettenbacher et al. (2015a, 2015b)















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Be Stars

- Rapidly rotating B-type stars that eject gas into a circumstellar disk
- Evidence for the disks
 - Rotationally broadened emission lines
 - IR excess
 - Linear polarization
 - Spatially resolved through interferometry
- Variable on time-scales of days to decades























- Role of binarity in Be stars past mass transfer events?
 - Spun up secondary orbiting stripped down remnant companion (neutron star, white dwarf, helium star)
 - High contrast at close separations



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Disk wind in AB Aurigae



Radial velocity (km/s)

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5.0

4.5



 Resolve Hα formation region in young accreting intermediate mass star

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- Bulk of Hα forms in disk wind from innermost regions (0.05 – 0.15 AU)
- Perraut et al. (2016)



- Material from close binary companion accretes onto surface of white dwarf
- When pressure and temperature of accreted material reach a critcal level, ignites in a thermonuclear runaway
- Expansion velocities of 500 – 3000 km/s





















- Many more science opportunities
 - 141 refereed papers and counting
- AO + updated detectors + community input
 - Many more years of productive science programs in the future













