Review of Day One

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Talks on Day 1

- *Optical Interferometry: Motivation and History* – P. Lawson
- *Theory of Optical Interferometry* – C. Haniff
- *Atmospheric Limits to Optical Interferometry* – M. Swain
- *Interpreting Visibility Amplitudes* – C. Hummel
- *Measuring Fundamental Stellar Properties Using Binaries* – C. Hummel
- *Astrometry* – B. Lane

Optical Interferometry: Motivation and History

- Began with Fizeau in 1867, then continued with Stephan and Michelson with a long period of inactivity
- Michelson and Pease did further work at Mt. Wilson in the 1920's-30's with more inactivity after both of their deaths
- Radio astronomy/interferometry during and after WWII helped develop many concepts

Optical Interferometry History con’t

- Optical interferometry efforts restart in a serious way in the 1950’s with the development of certain technologies and automation
- Speckle interferometry, personal computers, and automation move us into the modern age of interferometry (1974)
- After more than 10 prototype interferometers, there are now 3 facility-class ground-based interferometers and many space-based ones planned

The Theory of Optical Interferometry

- Review Key Ideas in the talk (yellow boxes) and make sure to take the Quizzes (green boxes)
- If we measure the Fourier components of our source we can reconstruct our “image” by taking the inverse Fourier transform of these components
- Intensity measured by the interferometer is a time-averaged quantity which varies co-sinusoidally

Theory con't

- We usually fix the argument of the co-sinusoid (kD) and then vary something in our interferometer (delay, baseline, wavelength, etc) in order to measure the intensity changes and derive the visibility V
- The only reason to match the geometric delay in the paths is because with this we can measure polychromatic light from our source

Theory con’t

- Need to have a clear (heuristic) idea of the process of measuring the fringe visibility and phase and what information you retrieve from these quantities
- Any source can be thought of as a superposition of points which together produce your fringe pattern
- The visibility V is the Fourier transform of the brightness distribution of the source; this FT is linear and invertible

Atmospheric Limits to Interferometry

- "Phase screen" concept of the moving atmosphere over the telescopes
- "Seeing" is a horizontal distribution of different refractive index air parcels moving above the telescopes
- Kolmorgorov approximation for the structure function of the atmosphere which allows you to define the quantity C_n^2

Atmospheric Limits con't

- Characteristic length scale (Fried parameter) r_o, temporal scale t_o and angular phase variance Θ_o of the atmosphere and the Strehl ratio S
- Value of merit for an interferometer is the coherence volume $r_o^2\, t_o$
- To be a "happy" astronomer, you might choose to ignore all this and just work with the published sensitivity of your instrument
- The rest of "us" like to monkey around with this

Interpreting Visibility Amplitudes

- Be aware of the detailed characteristics of your interferometer
  - Photometric FOV – can decrease fringe contrast
  - Interferometric FOV – set by the bandwidth of the channel recording your fringes
  - Aperture synthesis
  - Sensitivity

Interpreting Vis Amp con't

- Showed many nice examples of unresolved, UD, elliptical disk, LD disk, etc
- Gave you all bits of IDL code so you can try this out at home yourself
- Polychromatic interferometry allows you more UV sampling, but now you need some knowledge of the spectral characteristics of your source

Fundamental Stellar Prop. Using Binaries

- Most of what we know about stars we know from binary systems
- Fundamentals are:
  - Mass
  - Angular momentum
  - Chemistry
  - Luminosity
  - Effective temperature
  - Radius

Binaries con't

- Presented many useful relationships about stars
  - $F_{bol} = \sigma\,(\Theta/2)^2\,T_{eff}^{\ 4}$

- Demonstrated the power of using RV or eclipsing systems to make several detailed studies of binaries systems
- Pushing the theory with what we are now able to achieve

Astrometry

- Motivation for why you might want to do astrometry
- Several challenges for doing astrometry well:
  - Know delay
  - Know baseline vector
  - Know aperture pointing
  - Measuring the phase accurately
  - Dealing with atmospheric turbulence
  - Dealing with atmospheric dispersion

Astrometry con't

- Discussed details of several techniques
  - Wide-angle or global: SIM
  - (Very) Narrow-angle: (PHASES) PTI
  - Differential Phase: Hot Jupiters
  - Imaging Astrometry: within interferometric FOV

Today’s Talks

- *Stellar Diameters, Rotation and Pulsation* – Guy Perrin
- *Exo-Planet Detection with Astrometry* – Didier Queloz
- *Synthesis Imaging* – Claire Chandler
- *Closure Phases* – Chris Haniff
- *Science with Closure Phases* – Peter Tuthill
- *Stellar Atmospheres/Surfaces* – Jason Aufdenberg