

# Stellar/AGN photometric astronomy in the era of SDSS Phase V

## Cheat sheet on the pre-meeting presentations

### SCIENCE THEMES

#### ***Stellar System Architecture***

- We have statistics for Sun-like MS stars in the local neighborhood (< 25 pc)
- Statistics are input to population synthesis models
- What is stellar multiplicity across the HR diagram?
- How does multiplicity affect stellar evolution?
- Frequency and properties of systems with compact objects that result in explosions and GW

#### ***White Dwarfs***

- Binaries: LISA sources, progenitors to Ia SNe
- Pulsations, outbursts

#### ***Stellar-Mass Isolated Neutron Stars and Black Holes***

- Mass function, counting
- Implications for stellar death and gravitational waves

#### ***AGN***

- BLR sizes, BH masses
- Photometric variability: can be periodic or flaring
  - Physical origin unclear: instabilities? SNe? microlensing? TDEs?
- Light travel time: hours across the accretion disk, days across the BL region
- Dynamical time: days across disk, years across BL region
- SMBH binary merger could be a LISA source
- Changing-look quasars

#### ***Young Stars***

- Disk formation, accretion, evolution
- FU Ori Stars: Systems cycle through high and low states of accretion, and contribute large amounts of mass to the surrounding cloud. Dramatic eruptions.

#### ***Stellar Death***

- Which stars die and result in the transients / GW sources that we observe?
- Nucleosynthesis: origin of the heavy elements
- Interaction between stars, gas, SNe

#### ***Asteroids***

- YORP effect

#### ***Milky Way***

- How did the disk form?

#### ***Exoplanets***

- What stars host planets?

## FACILITIES

### *ZTF*

- 3000 visits/source/year
- 3 filters
- 47 sq deg FOV
- 5-sigma limit in r-band is 20.5 mag
- Northern Sky Survey: 2 visits/night (g,r) → 3d cadence, 23,675 deg<sup>2</sup>, 4325 deg<sup>2</sup>/night
- Galactic Plane: nightly sweep of plane ( $|\text{bl}| < 7$  deg), 2800 deg<sup>2</sup> footprint, 1475 deg<sup>2</sup>/night

### *SPIRITS*

- Target 200 galaxies with the Spitzer Space Telescope (2014-19)

### *Palomar Gattini-IR*

- 15000 deg sq every night in J-band to 16.4 mag, first light Sept 11, 2018
- 25 deg sq FOV

### *SDSS-V*

- MWM: > 6M stars, all-sky. R ~ 22,000, IR (APOGEE)
- BHM: >400,000 sources (SMBH), all-sky. Optical (R~2000)
- LVM: >25M spec, 3000 deg<sup>2</sup>, ISM, stellar pop in MW to nearby gal). 3600-10000 AA, R~4000.
- 4-60 epochs per source
- 2020-2024
- $M_H < 12$  (1.51-1.7  $\mu\text{m}$ ),  $M_G < 18$  (0.37-1  $\mu\text{m}$ )
- NIR and optical multi-fiber spectroscopy rapidly reconfigurable

### *TESS*

- All-sky, wide-field survey of solar-type and cooler stars
- 4 cameras, combined FOV 24° x 96° per pointing
- 600-1000 nm bandpass
- Observes 200,000-400,000 stars every 2 minutes. LC released.
- Observes 420 million stars every 30 minutes. Release images, not LC, but community-led pipelines are available.
- Data product: catalog of parameters and mags for 250 million stars

### *Tomo-e Gozen*

- The world's first wide-field sub-second framing optical camera
- FOV: 20 deg sq
- Default observing mode is 2 Hz to 17 mag
- Survey: 7000 sq deg with 2 hr cadence to 18th mag (6s exposure)
- Simultaneous observations with radio (Kashima NICT) and X-ray (NICER)

## RESULTS FROM INDIVIDUAL FACILITIES

### ***Cadenced RV observations with SDSS (Carles Badenes)***

- Find binary+ systems using RVs
- For most targets, you don't get full orbits
- Result: first stellar-mass non-accreting black hole
- Result: enough pre-merger WD binaries to explain Ia SNe
- Result: as stars climb the RGB, there are fewer short-period systems
- Result: more short-period systems among lower-metallicity stars

### ***Finding interesting binaries from Gaia (Timothy Brandt)***

- DR3: accelerations for millions of stars that are nearby ( $d < 200$  pc, sep 2 – 100 AU)
  - A way to find and weigh Sirius-like binaries, and non-interacting NS and BH
  - Confirmation & masses require RVs
- Can also find binaries that are more distant ( $< 500$  pc) and not accelerating (sep  $> 20$  AU)
  - Large (~200,000) sample
- Need light curves from ZTF, and RVs and chemistry from SDSS-V

### ***Double Degenerates from ZTF (Kevin Burdge)***

- ZTF is significantly increasing the sample of eclipsing WD binary systems, LISA sources

### ***Pulsating White Dwarfs (J. J. Hermes)***

- Pulsations: 100-1500s periods, 0.1-3% amplitudes and higher
- g-mode pulsations driven by partial ionization of He or H
- From pulsations (+spectra) you can actually measure rotation rates and mass
- As a WD cools, convection zone deepens, and you get longer-period pulsations
- They also exhibit outbursts

### ***Binaries in ZTF (Thomas Kupfer)***

- SN Ia progenitor candidate (orbital period 70 min) found serendipitously
- New class of radial mode hot subdwarf pulsators
- The most compact hot subdwarf binary