Milky Way and Local Group Sessions
WFIRST Workshop: Day 2

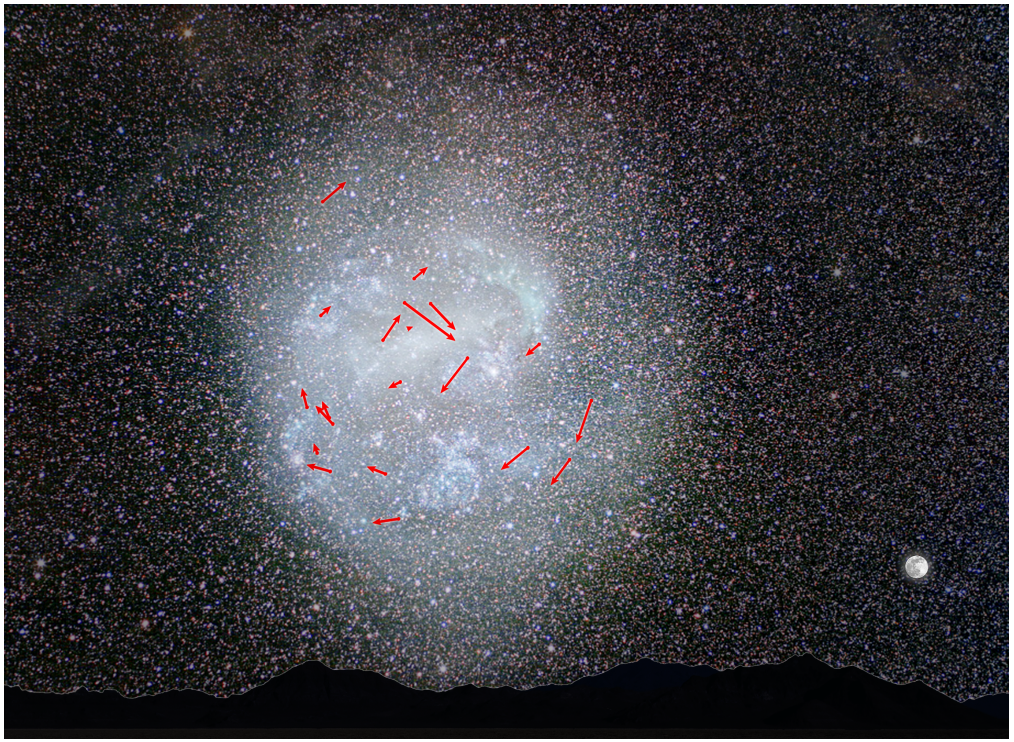
Rappers: Steven Majewski (UVa) & David Soderblom (STScI)

G&LG: we promised astrometry!

- R. van der Marel (STScI): Local Group Proper Motions
  - Stellar dynamics and kinematics arise from gravity and interactions, hence reveal dark matter, masses, gradients, and processes such as "disk heating."
  - RVs are distance-independent but 1-D; need PMs to go to 3-D.
  - What's needed?
    - 1km/s at 7 kpc for globular internal dynamics
    - 10 @ 70 kpc for MW halo/satellite dynamics
    - 100 @ 700 kpc for LG dynamics
    - Corresponds to 30 μarcsec/yr (water molecules at 1 m)
  - Feasible with HST, but fields small (reference objects scarce)
  - Large fields and depth of WFIRST break through the limits.
    - Larger pixels, but can reach background galaxies.

      2X less precision as HST but 100X larger field for root N

- V. d. Marel (cont.):
  - Gaia: spectacular for dynamics of much of MW
  - WFIRST: in MW, HLS and Bulge survey go much deeper than Gaia (Gaia hits number limit)
  - WFIRST excels for faint targets:
    - Bulge and halo kinematics
    - Stellar streams
    - Hypervelocity stars
    - Dwarf galaxies
    - Internal motions



Internal rotation of LMC by vdM & Kallivayalil.

G&LG parallel talks, Day 2

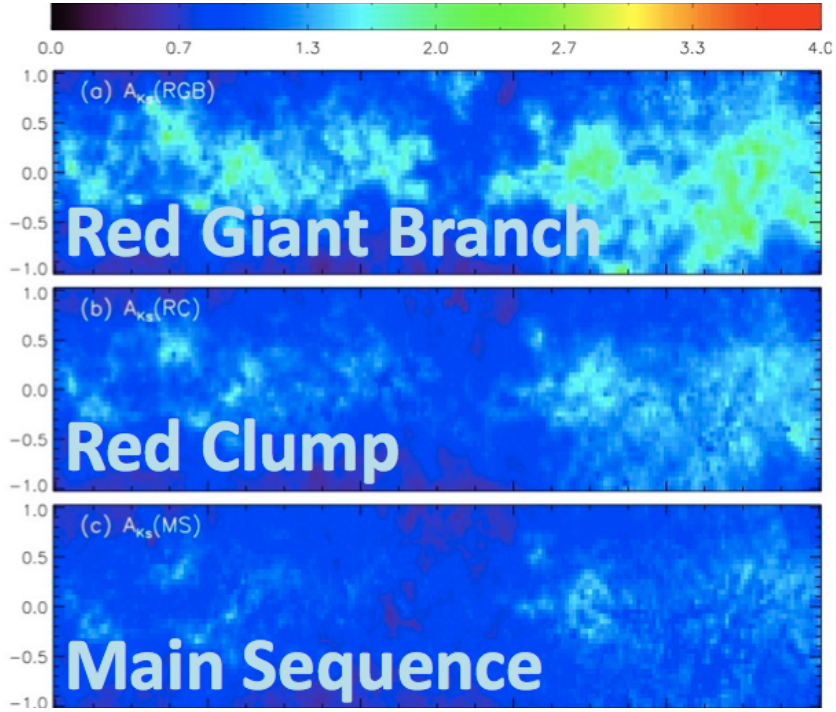
R. Street (LCOGT): WFIRST and Binary Stars

- Binaries are fundamental:
  - Their number show star formation produces lots of binaries
    - What are the mechanisms?
  - They reveal stellar physics and physical processes
  - Few low-mass binaries known
    - Need separations, mass ratios, eccentricities, …
  - Detect binaries as doubles: visual, astrometric, and eclipsing
  - WFIRST: Micro-lensing survey sensitive to binaries of all mass ratios
    - Samples all of Galaxy
    - Also detect planets
  - WFIRST: Asteroseismology for R and M in high cadence fields
  - WFIRST: Parallaxes provide independent check on R, M for some stars (see Gould talk)

G&LG parallel talks, Day 2

G. Zasowski (JHU): Dust in the Milky Way & Local Group

- Dust is everywhere; holds metals and chemicals
- Sources include SNe, evolved stars
- How to assess reddening:
  - SED modeling
  - Dust proxies (e.g., long λ emission, H I emission, DIBs)
  - Statistical distributions



- WFIRST+Gaia: 3-D dust maps
  - Bulge microlensing field
    - *– trig π's real benefit for 3-D mapping*
  - Additional bulge + disk fields
  - Nearby galaxies (e.g., as shown in PHAT talk)
  - Star forming regions

G&LG parallel talks, Day 2

D. Ardila (Aerospace Corp.): Searching for Young Stars

- Need young stars for Initial Mass Function
- Role of planets in clearing and expelling disk
- Disk composition vs. radius
- Planet migration: How and when
- WFIRST: Distant star-forming regions in MW (and LG)
  - K=19 means 0.1 M_{sun} at 20 kpc Galactic radius
- WFIRST: Stellar and sub-stellar pops in SFRs
  - H=18 reaches 1 M_{Jup} at 1 Myr; Grism to get type
- WFIRST: Finding closest young stars kinematically
  - Need additional info to confirm youth
- WFIRST: Coronagraphy for disks and disk structure/evolution

G&LG parallel talks, Day 2

M. Messineo (MPIFR): Massive Stars in Giant Molecular Clouds

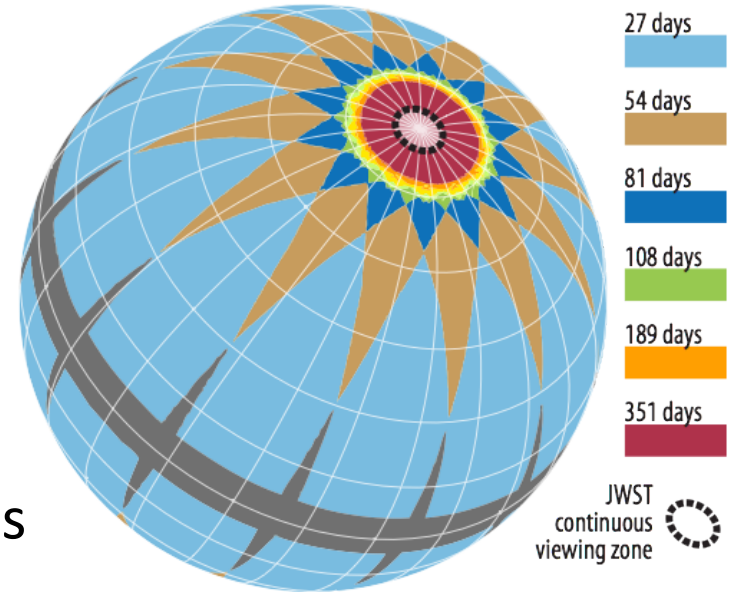
- GMC G23.3–0.3 seen in radio
- K-band found ~40 OB stars in G23.3–0.3 GMC complex
- 11 Of stars at 5-8 Myr
- Glimpse data critical

Science Preparation and Follow-Up Facilities

TESS and Galactic Astronomy (Stassun)

- 2-min cadence opportunities
  - asteroseismology, mainly red giants
    (TESS nearby, WFIRST distant stars)
  - stellar granulation "flicker"
    (does it extend to IR & WFIRST?)

  accurate gravities, ages for field stars
  - eclipsing binaries: fundamental physics



- 30-min cadence for full frame downloads
  - stellar weather and rotations (gyrochronology)
  - variable stars (better lightcurves for all known variables)

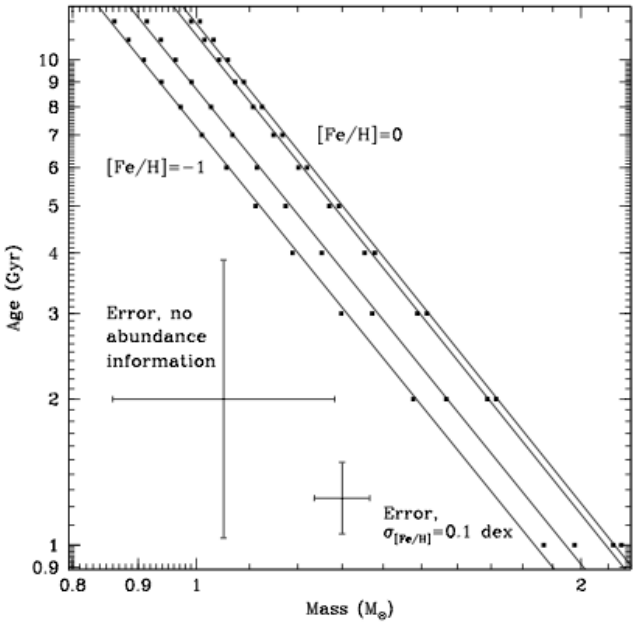
- WFIRST coronograph follow-up
  - circumstellar environments for dust/debris disks

Science Preparation and Follow-Up Facilities

Infrared Spectroscopy (Bovy)

- APOGEE: high resolution, multifiber H-band spec'y
  - Dual hemisphere capability will soon exist.
  - Enables "follow-up" in heavily extinguished regions.
  - Precision RVs and multi-element chemistry.
  - Needed for complete picture of MW disk/bulge.
  - Asteroseismology needs [Fe/H] to get accurate ages.

  - Step toward larger instruments on larger telescopes.
    - E.g., MOONS: 0.8-1.8μ on VLT
      medium and high res arms



Science Preparation and Follow-Up Facilities

Infrared Photometry, Astrometry, (μlensing) (Dekany)

- VVV: Charting the Milky Way bulge, disk
  - J,H,K mapping stars and dust
  - Time series data

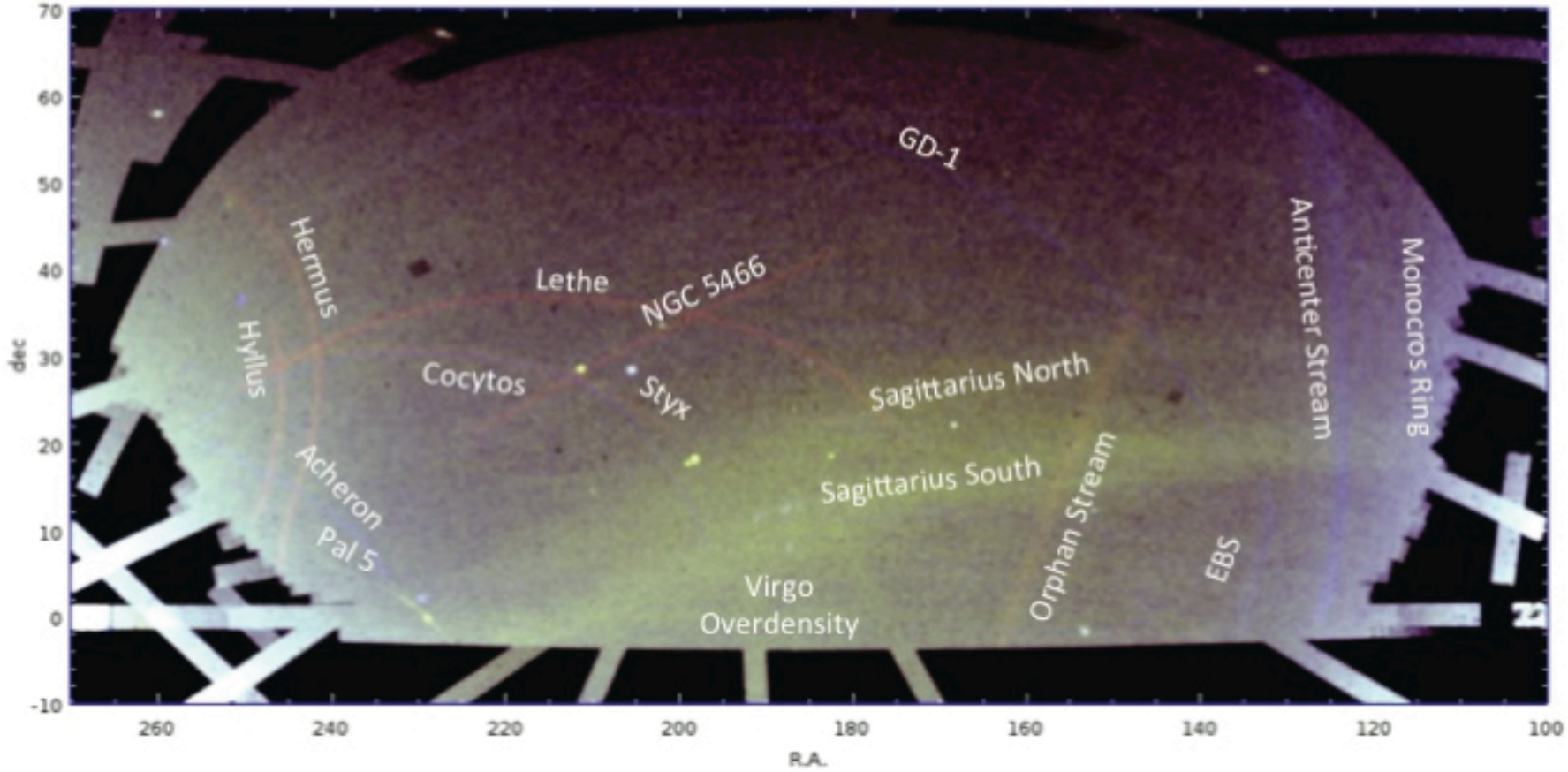
- WFIRST pre-cursor, as NIR time-series survey of bulge, disk
  - Training for use of massive stellar database, esp'ly crowded field.
  - Provide science cases
  - Input catalogs for follow-up
  - Extend temporal baselines (proper motions, μlensing)

- WFIRST for VVV
  - Recalibration
  - Deblending
  - Additional epochs

Science Preparation and Follow-Up Facilities

LSST Synergy (Grillmair)

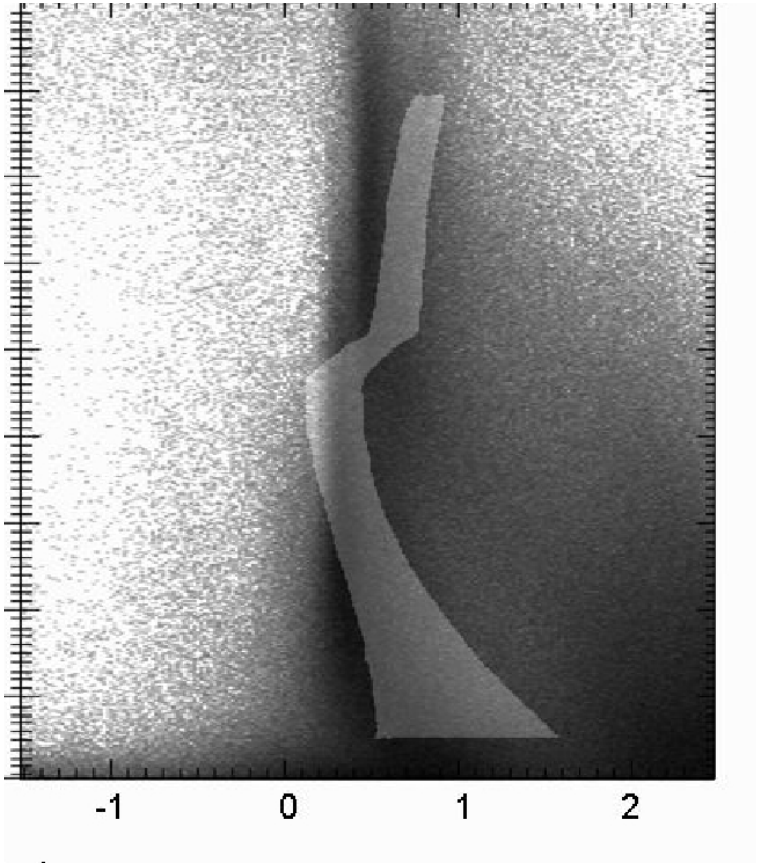
- Halo substructure, streams via matched filtering.

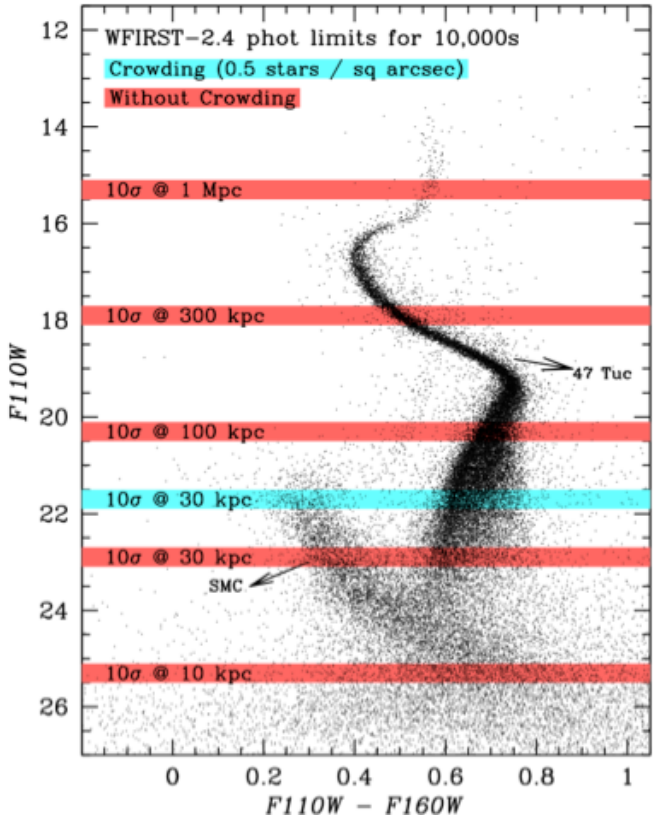


Science Preparation and Follow-Up Facilities

LSST Synergy (Grillmair)

- Halo substructure, streams via matched filtering.
- WFIRST: Star counts, wide area, but reduced color span.

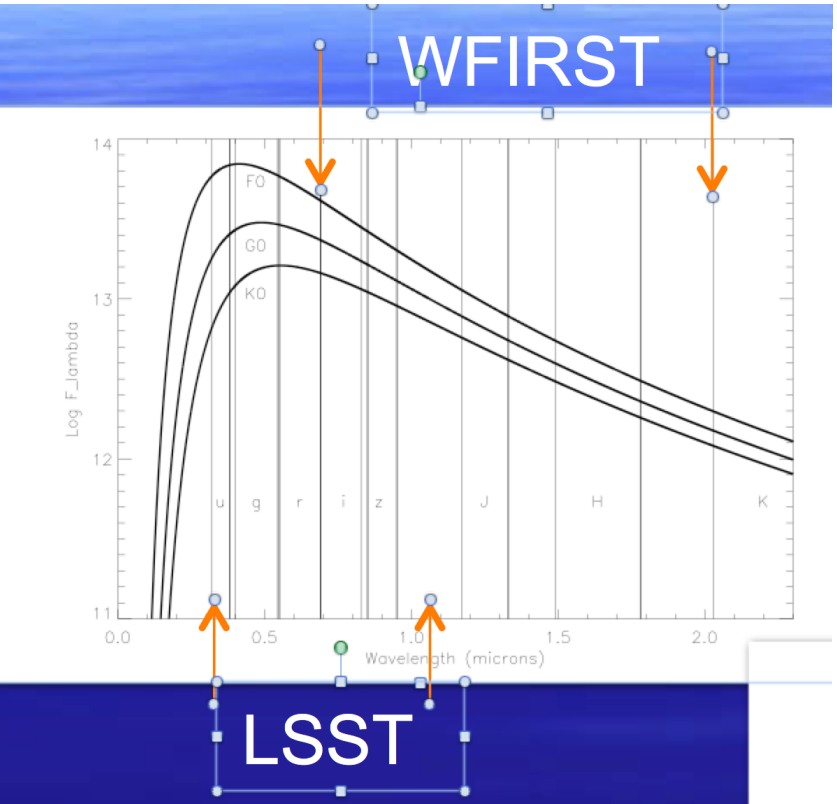


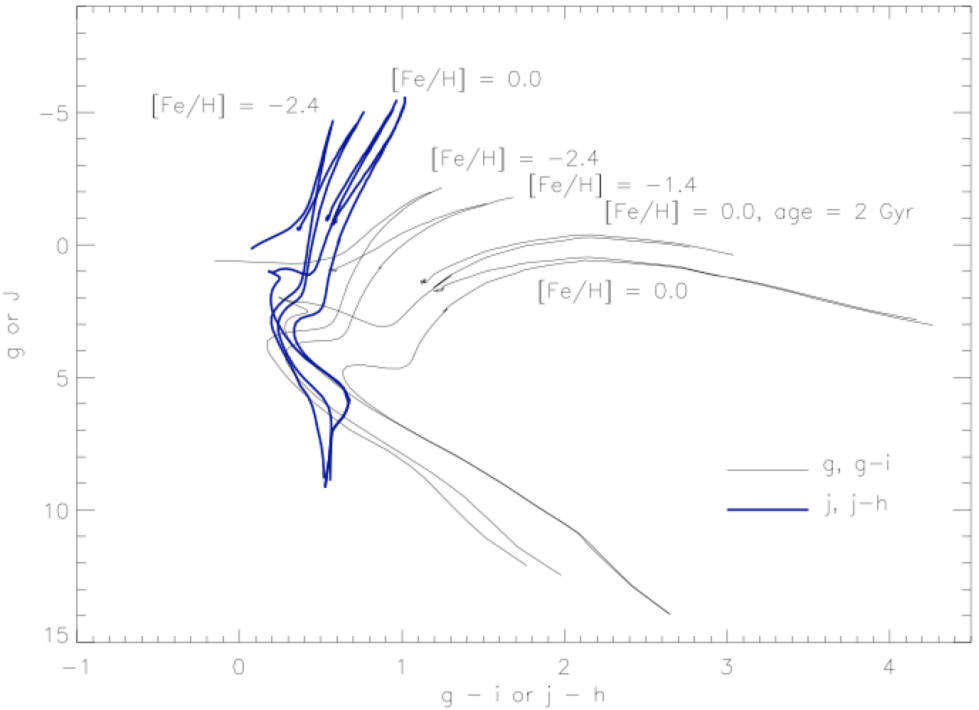


Science Preparation and Follow-Up Facilities

LSST Synergy (Grillmair)

- Halo substructure, streams via matched filtering.
- WFIRST: Star counts, wide area, but reduced color span.
- WFIRST + LSST: Widens λ span, widens stellar color span. increases contrast of detectable features.





WFIRST-LSST Synergies for Local Volume Exploration

(Grillmair)

	WFIRST HLS	LSST
	2000 square degrees	>18,000 square degrees
Training s/g separation	FWHM ~ 0.11”	FWHM ~ 0.7”
	0.9 – 2.0 µm	ugrizy
	~10 km/s (?) RVs to AB ~ 20.5	none
	0.1 mas/yr PMs to V ~ 20	0.3 mas/yr PMs to r ~ 20
	RR Lyrae distances to 2%	RR Lyrae detection to > 1Mpc

Wm. Dawson (LLNL): Blending

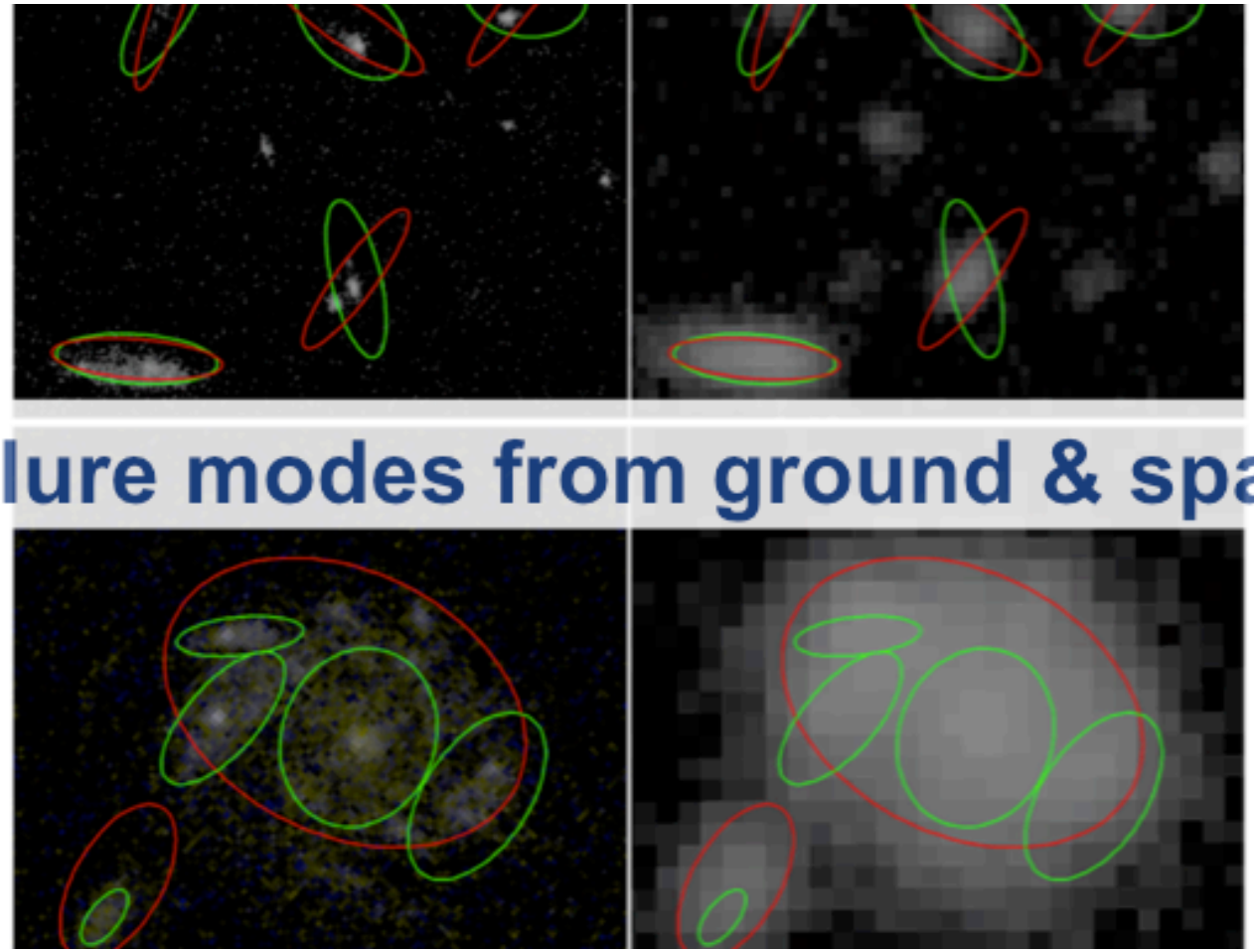
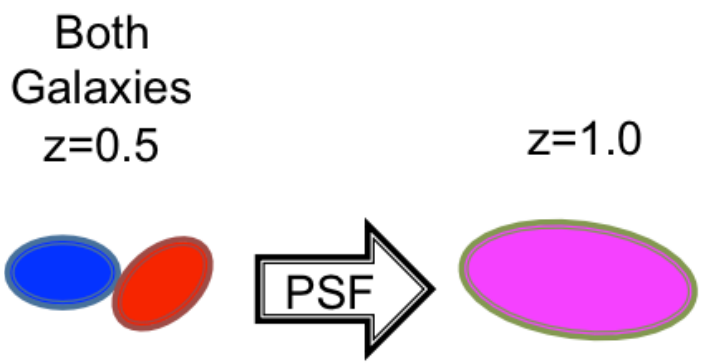
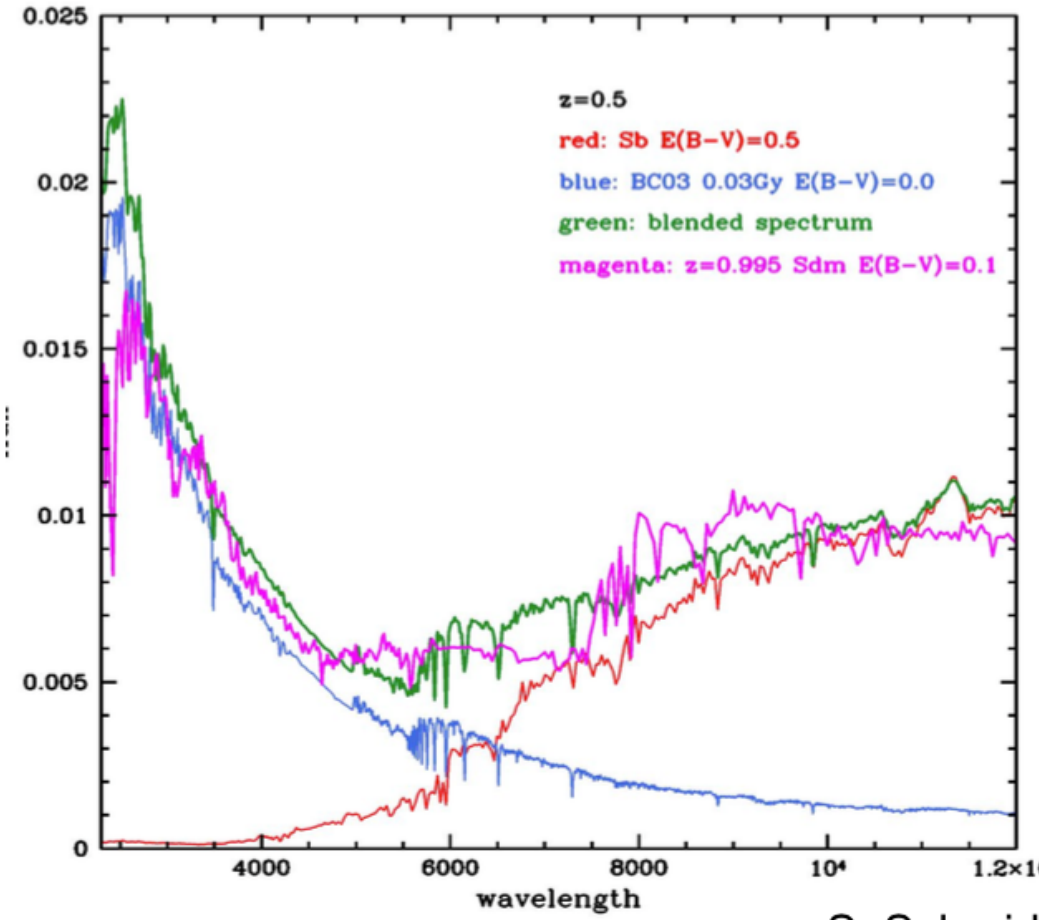


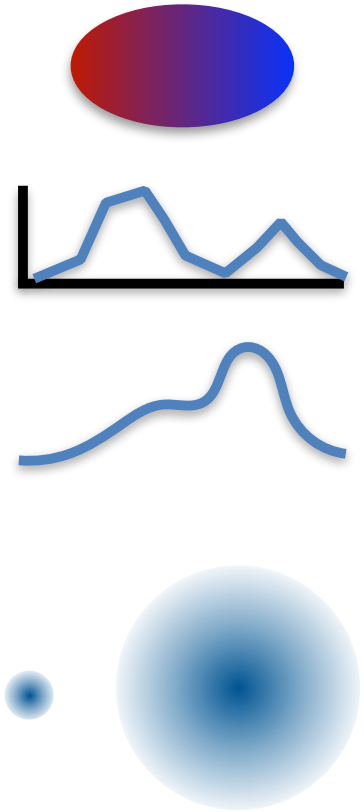
Photo-z's of blended galaxies can be biased





S. Schmid

Key observables: tools in mitigating blending



- Color spatial gradients
- Photometric redshifts
- Light profile morphology
- Space imaging
  - Best ground seeing epochs (more for LSST)

Methods for combining survey data

1. Catalog comparison
2. Interim samples from 1 survey + pixel-level analysis in 2nd survey
   - Need many samples
3. Interim samples from both surveys
   - Need many samples + binning of model parameters
4. Joint analysis of pixel data

From Schneider talk on Monday

Challenge: methods 2 - 4 often require re-analyzing pixel data

Implications for the Future

- Area vs. Depth: new considerations = blending
  - What's good for WFIRST?
  - What's good for LSST?
- Best means of integrating WFIRST and LSST?
- Computational requirements (joint fitting)