Swift UV/Optical Telescope
Ultraviolet Imaging of the Star-Forming Regions of M81*

Erik Hoversten
Caryl Gronwall, Dan Vanden Berk
Swift Mission Conference
November 19, 2009

* and Holmberg IX
The View From...

Outer Space

UVOT: uvw2, uvm2, uvw1

New Mexico

SDSS: g, r, i
Messier 81

- AKA NGC 3031, Bode’s Galaxy
- Discovered by Bode in 1774
- Grand Design Spiral: SA(s)ab
- LINER (Heckman 1980)
- $V = 7.9$
- 3.6 Mpc
- 27 x 14 arcminutes
- SFR = 0.4-0.8 $M_\odot$ yr$^{-1}$ (Gordon, et al. 2004)
- $A_V = 0.5 - 1.0$ (Kong, et al. 2000)
- Recent interaction with M82 tens of Myr ago
Holmberg IX

- AKA UGC 5336
- Discovered by van den Bergh in 1959
- Dwarf Irregular Galaxy
- Satellite of M81
- $V = 16.5$
- 1.4 arcseconds across
- Home to Holmberg IX X-1 ULX- monitored by Swift
- At least 20% of stellar mass younger than 200 Myr-
  youngest nearby galaxy? (Sabbi, et al. 2008)
- Tidal dwarf from M81-M82 interaction?
- Nearest candidate tidal dwarf- none in Local Group
Coincidence Loss

- AKA “pile up”
- Simple correction for point sources, unknown for extended sources
- Modeled UVOT response to determine at what level Co-I loss becomes important (Breeveld, et al. in prep)
- UV filters mostly good, optical bad
Coincidence Loss

- Replace UVOT optical imaging with SDSS
- Correct individual UV knots which need correction
- Byproduct: extends SEDs into NIR
Identification of UV Knots

- Stacked circular median filter to fit diffuse background
Photometry

- Use SEDs to fit ages, SFHs of individual star forming regions
- Are the star forming regions in M81 & Holmberg IX similar?
- Evidence of interaction with M82?
- M81, Holmberg IX well studied- useful for testing our techniques before applying to other galaxies
Size Distribution of Star Formation Regions

• Distribution of sizes different in M81 and Holmberg IX
• Can probe relationship between region size and galaxy luminosity (Youngblood & Hunter 1999)
Dust

• Choice of dust model has significant effect on interpretation of UV flux from a source

• $R_V = A_V/E(B-V)$ varies from 2.2 to 5.8 with mean 3.1 in MW (Fitzpatrick 1999)

• Provide clues into cause of bump-graphite vs. PAH?

• Insights into galaxy structure and evolution?
Pixel by Pixel SED fitting

- Accurately recovers $A_V$ range from Kong, et al. 2000
Variations in the Stellar Initial Mass Function

- Evidence accumulating for non-universal stellar initial mass function in external galaxies
- Luminosity: Hoversten & Glazebrook 2008
- Both: Hoversten & Glazebrook in prep.
- => Star formation rates, gas depletion timescales, M/L ratios need to be revised
Integrated Galaxial Initial Mass Function

- IMF or IGIMF
- IGIMF: galaxy wide IMF appears different due to sampling IMF across all star forming regions (Weidner & Kroupa, 2005)
- No 100 M_☉ stars from 75 M_☉ molecular clouds
- Star cluster mass distribution sensitive to SFR of galaxy
- IGIMF theory is controversial (Elmegreen 2006)
UVOT to the Rescue?

GI Proposal submitted/Fill-ins for deep observations of HI rich low surface brightness galaxies