Preserving Low Surface Brightness Light in LSST Imaging

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Overview

- LSB science: history & motivation
- LSST as a new LSB frontier
- Observational challenges & techniques
- ICL / LSB flux contamination
- Post-facto LSB flux repair



The Faint Virgo

Burrell Schmidt 0.6m $\mu_V = 28.5 \text{ mag arcsec}^{-2} (1\sigma)$ Mihos et al. (2005)

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A significant component of the cluster



Isophotal thresholding technique Burke et al. 2012

"it is a significant component of the cluster, with a large effect on its dynamics."

Oemler, 1973

Zwicky (1951, 1957, 1959); de Vaucouleurs (1960); Gunn (1969); de Vaucouleurs and de Vaucouleurs (1970); Welch and Sastry (1971, 1972); Oemler (1973); Kormendy and Bahcall (1974); Gunn and Melnick (1975); Melnick, White, and Hoessel (1977); Mattila (1977); Thuan & Kormendy (1977); Bernstein et al. (1995); Gregg & West (1998); Gonzalez et al. (2000)



LSB observational challenges

The ICL and other LSB phenomena are incredibly faint (<1% sky), and as such, very difficult to measure.

Issues:

- Appropriate observing technique
- Source extraction and masking / modelling
- Sky estimation → potential over-subtraction
- CCD artefacts (edge effects)
- Imaging ghosts / haloes / diffraction spikes



F160W masked image of the AS1063 HFF cluster.

Montes & Trujillo, 2018

LSB contamination

CCD edge effects

Sky over-subtraction due to bright sources

Sky over-subtraction due to crowded fields



LSB contamination

Sky oversubtraction around bright or extended objects affects many contemporary wide-area imaging surveys.

Kelvin et al., in prep



Sky oversubtraction*



*oversubtraction may lead to negative troughs and, in the extreme, positive haloes

LSB flux repair



Multi-model flux-threshold divot correction | XCS cluster 35 | HSC i-band Kelvin et al. in prep.

Summary

- Era of μ_r > 30 mag arcsec⁻² has arrived, and offers significant potential for furthering LSB science.
- LSST will detect ICL in Virgo in the first few frames, revealing crucial information on the accretion history and dynamical evolution of galaxy clusters.
- The extremely faint nature of the ICL and other LSB phenomena presents significant observational and data processing challenges in an era of big data LSB science → LSST!
- Post-facto image corrections does work, but preferable to modify existing DM software to accurately account for / preserve LSB flux.