YOUNG STELLAR POPULATIONS IN M31

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ABSTRACT
We present a comprehensive study of star–forming (SF) regions in the nearest large spiral galaxy M31. We use GALEX far–UV and near–UV imaging to detect young massive stars and trace the recent star formation across the galaxy. The far–UV and near–UV flux measurements, combined with ground–based data for estimating the reddening by interstellar dust, are used to derive ages and masses of the star–forming regions. The GALEX imaging, combining deep sensitivity and entire coverage of the galaxy, provides a complete picture of the recent star formation in M31 and its variation with environment throughout the galaxy.

INTRODUCTION
Young massive stars are a robust tracer of recent galaxy evolution. They emit powerful UV radiation. In particular, far–UV imaging is ideal to detect these stars, which are confused with older stellar populations in observations at other wavelengths. Most young massive stars are born in associations. The FUV - NUV colour of young associations is very sensitive to the age of the population, because massive stars evolve rapidly. We estimate the ages of young SF regions from their FUV-NUV color, and their masses from the extinction-corrected UV luminosities. These results are used to study the recent star formation in M31.

DATA
We selected 7 GALEX fields covering the entire disk region of M31, with homogeneous exposure time. Each GALEX field (1.2deg diameter) has far–UV (134.4–178.6nm, FUV) and near–UV (177.1–283.1nm, NUV) imaging. We also used multi-band optical data from the KPNO survey by Massey et al. (2006).

No. Field Name Field Center Exposure Time Threshold
1 NGA_M31_MOS11 RA (deg.) Dec. (deg.) (s) c/s/pixel
1 12.2040 42.9551 3340.35 0.00397
2 NGA_M31_MOS12 12.1648 42.0309 2702.75 0.00387
3 NGA_M31_MOS13 11.4031 42.3702 3244.45 0.00365
4 NGA_M31_MOS14 11.2531 41.6838 3589.70 0.00373
5 PS_M31_MOS00 10.6036 41.2777 3760.10 0.00353
6 NGA_M31_MOS00 10.1740 40.8165 3681.30 0.00324
7 PS_M31_MOS03 9.9574 40.5585 1182.20 0.00446

DETECTION
We used the field “NGA_M31_MOS00” exposure 6,811s, to test the limit of our current detection threshold.

Fig.1. Detected SF regions in “NGA_M31_MOS00” field, using three different thresholds (Red/ blue/orange contours: two / three / five sigma above the mean background). The solid circle is our selection field of view (excluding the edge). Enlargements of five sample regions (BOX 1-5) in this field are shown in the right panels.

INTERSTELLAR EXTINCTION
We estimated the extinction by interstellar dust for each SF region from multi-band photometry (taken from Massey et al. 2008) of the OB stars within the SF contours, using stellar model colours (Bianchi et al.).

Fig.2. Left – Number distributions of reddening for OB stars and detected SF regions. Right – Spatial distribution of selected OB stars and detected SF regions.

AGES AND MASSES
We estimated the ages of the SF regions by comparing the measured FUV - NUV colour with simple stellar population synthesis models, exploring effects of metallicity and dust type (e.g. Bianchi 2008). We then estimated the masses from the reddening corrected UV luminosity.

Fig.3. Left: Colour-magnitude diagram of the SF regions, Middle: Age vs. mass: two metallicity (Z=0.02 and 0.05) with MW extinction, Right: Age vs. mass: three types of interstellar dust (MW: Milky Way, AvgLMC: average LMC, LMC2: 30 Doradus) with Z=0.02

SPATIAL DISTRIBUTION
The SF regions follow the disk structure of M31, out to outermost radii.

Fig.4. Yellow contours are the detected SF regions. Dashed-line ellipses are drawn at 18'(red), 28'(orange), 33'(green), 48'(blue), 63'(purple), 88'(cyan), and 120'(yellow) distance from the galaxy centre (de-projected assuming an inclination of 77.7 degrees).

Fig.5. Distribution by de-projected distance: a, b, mass, c, size, d, mass-per-unit-area of the SF regions. The dashed lines mark the radius of ellipses in Fig.4 (colours as in Fig.4).

CONCLUSIONS
We estimated ages and masses of SF regions in M31, detected from FUV imaging. Most are younger than 400 Myrs (UV is not sensitive to older ages). Interestingly, there are no massive associations at young ages (Fig.3.a), suggesting a decrease of the star-formation rate. We estimated the SFR in three time intervals adding the masses of the SF regions of corresponding ages. These are restricted by our detection limit. Fig.6 shows the recent decrease of the SFR (black bar: SFR in a time bin, blue bar: average SFR in the past 400 Myr).

FUTURE WORK
We will compare the SF regions’ parameters from the integrated measurements with resolved studies of their stellar populations (from ground-based and Bianchi’s HST programs data). We will estimate ages and masses from deeper GALEX images to test the limit of our current detection threshold.

REFERENCES
Bianchi, L. 2008, APSS, 41B

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