The blue spheroids in the nearby universe

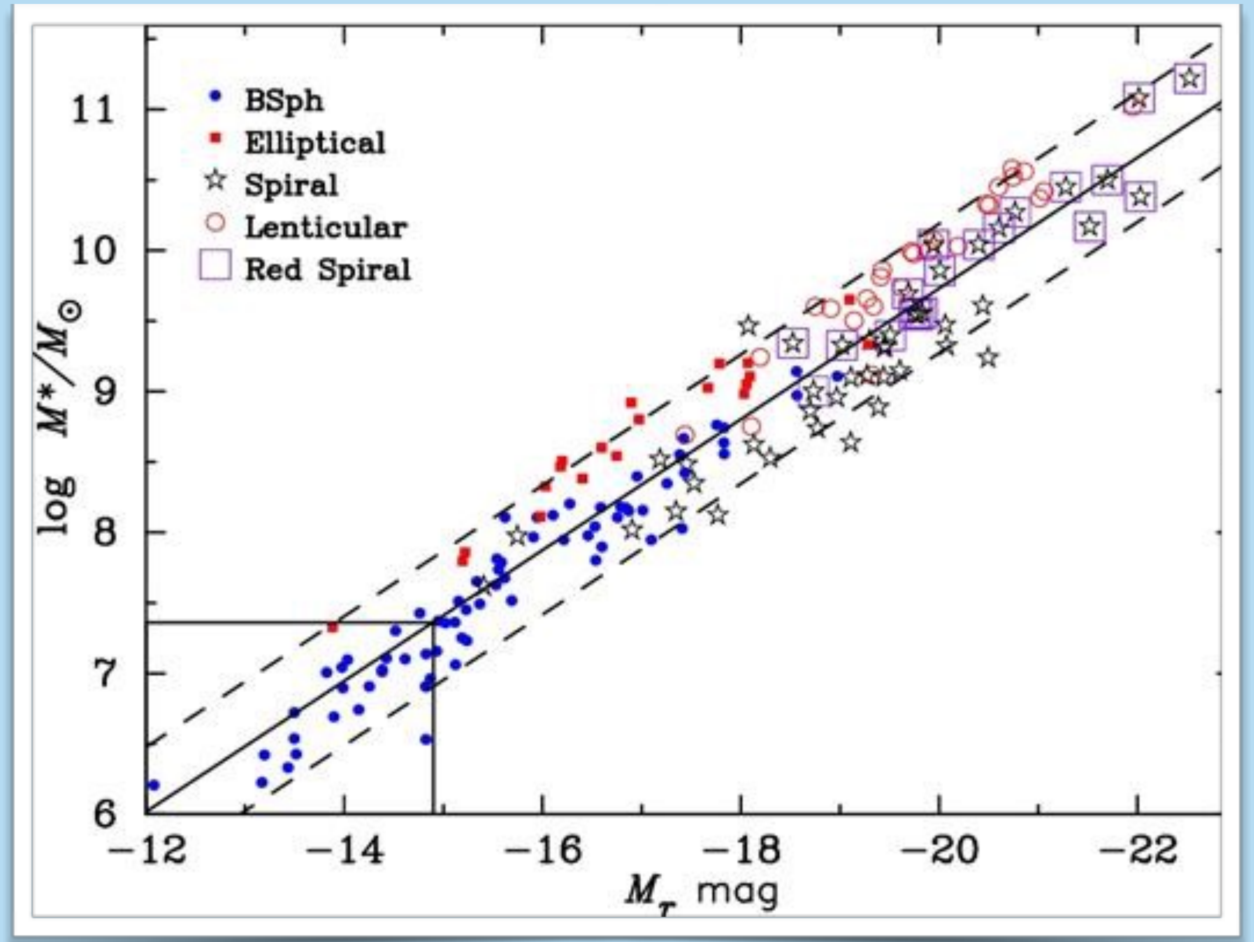
Smriti Mahajan

Indian Institute of Science Education and Research Mohali (IISERM), India

+ M.J. Drinkwater, S. Driver, A.M. Hopkins, A.W. Graham, S. Brough, M.J.I. Brown, B.W. Holwerda, M.S. Owers, K.A. Pimbblet

2018, MNRAS, 475, 788

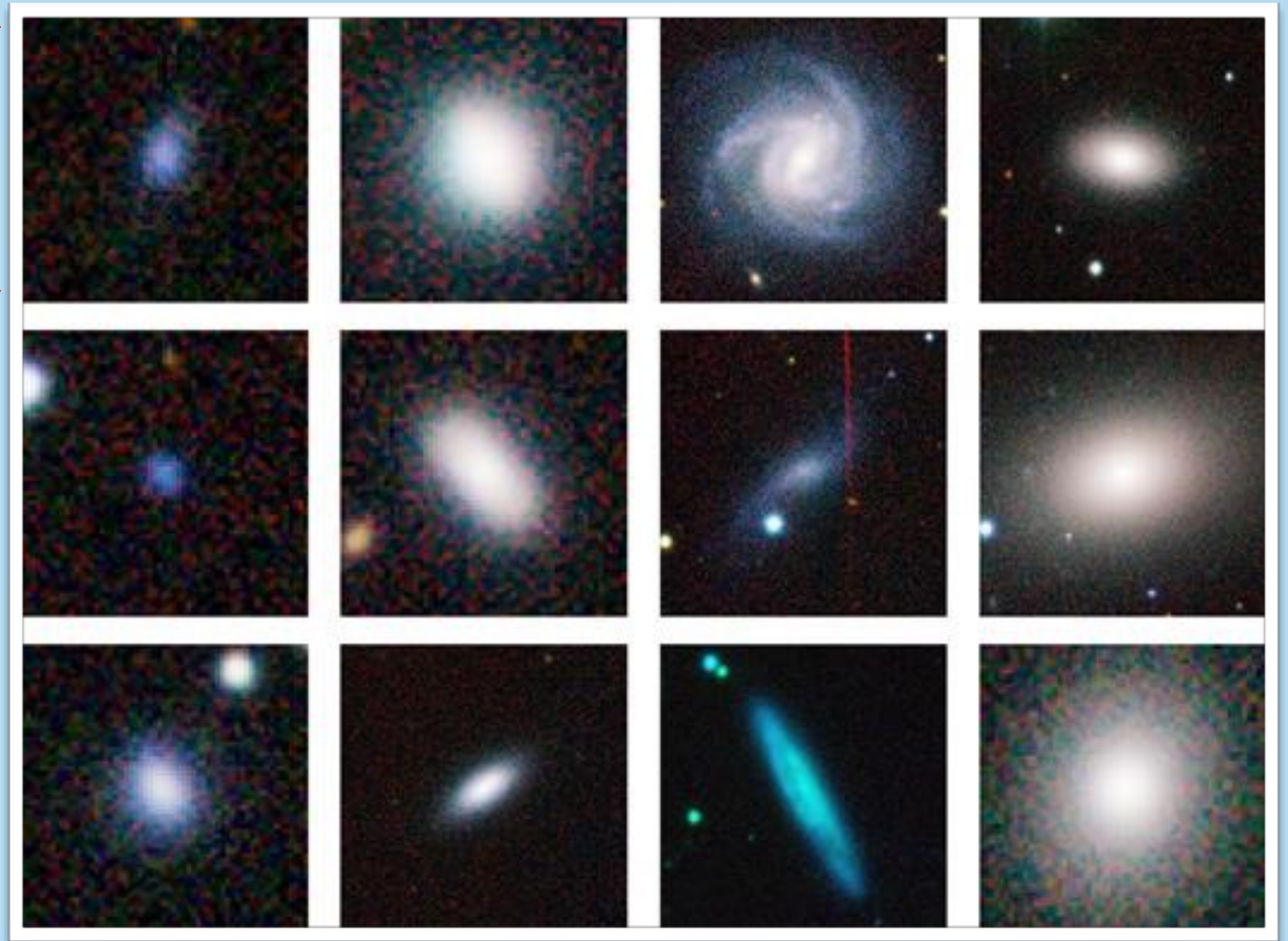
Sample



- Galaxy and Mass Assembly (GAMA) survey
- Data coverage of ~ 230 sq. deg. on sky in 21 wavebands & spectroscopic redshifts for ~ 200,000 galaxies with $r < 19.8$ mag in the equatorial fields
- For this work galaxies are chosen to be within 87 Mpc (0.002<z<=0.02)
- Limiting magnitude of our sample is M_r = -14.9 mag
- Limiting mass, log $M^*/M_\odot$ = 7.36

smritimahajan@iisermohali.ac.in

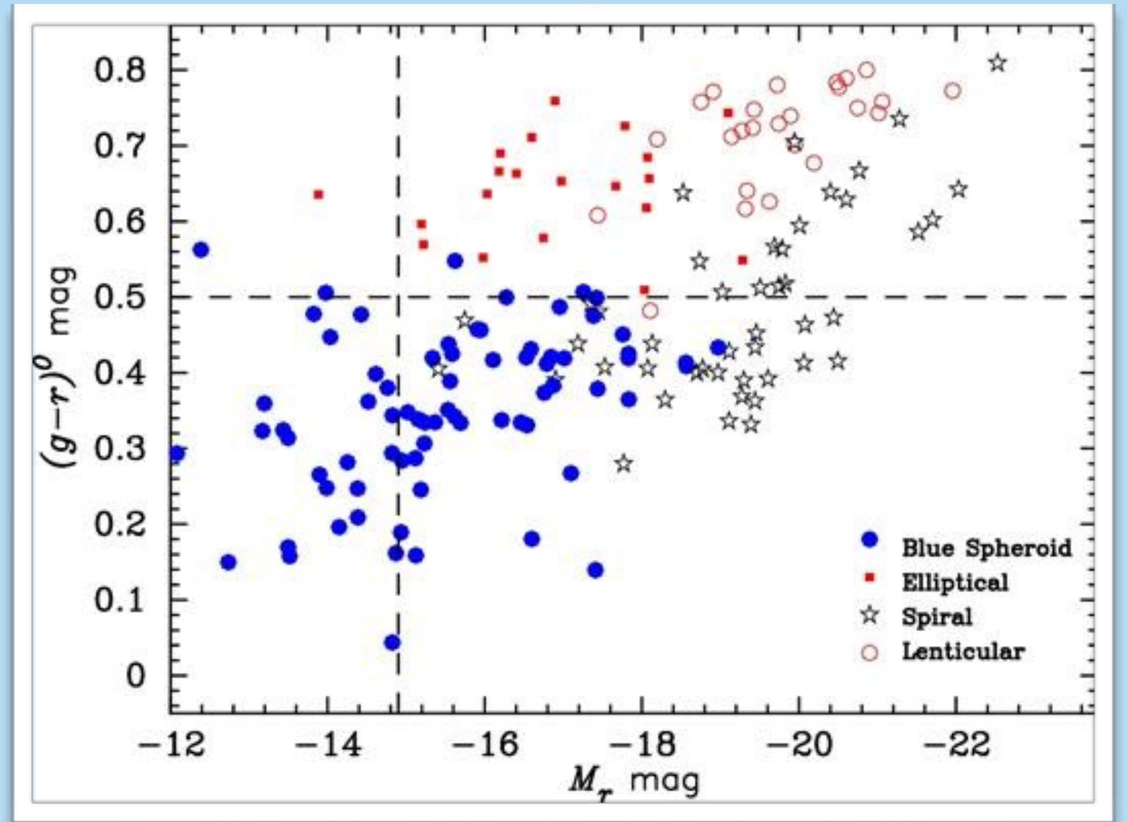
Morphological classification



Dwarf galaxies dominate this sample:
~ 45% Irregulars, 17% BSphs

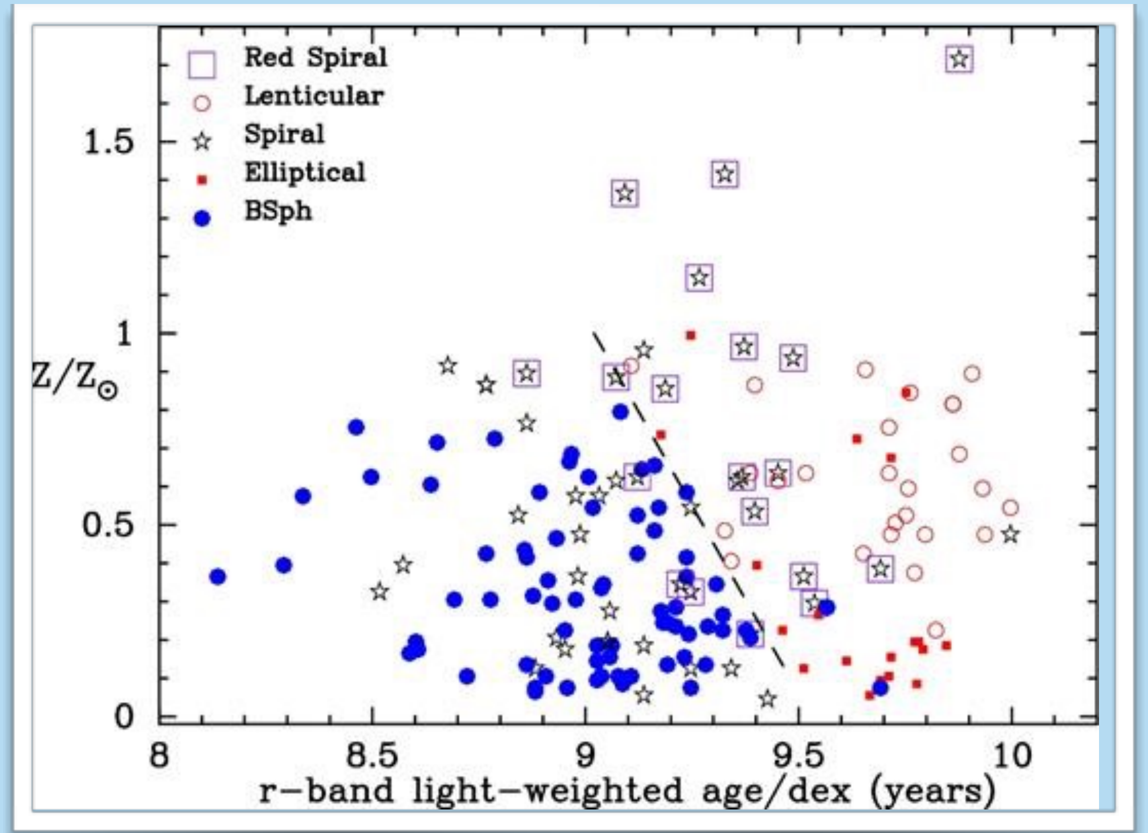
BSphs are very similar to early-types in shape

smritimahajan@iisermohali.ac.in



Physical properties

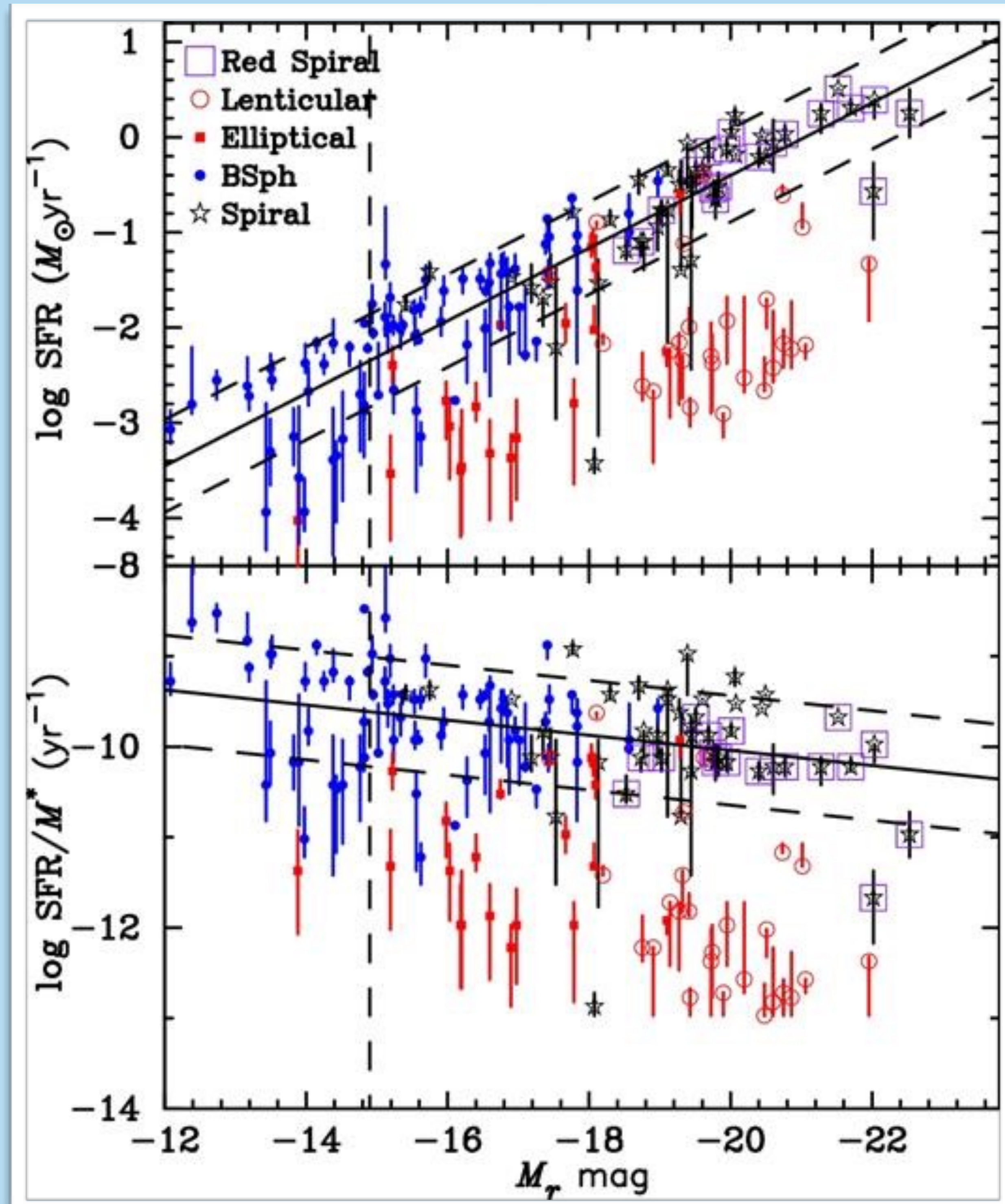
- Spheroids and disc galaxies form different sequences in the colour-magnitude plane.
- They are also well separated in the age-metallicity plane.



BSphs have evolved like the disc galaxies.

smritimahajan@iisermohali.ac.in

Star formation properties

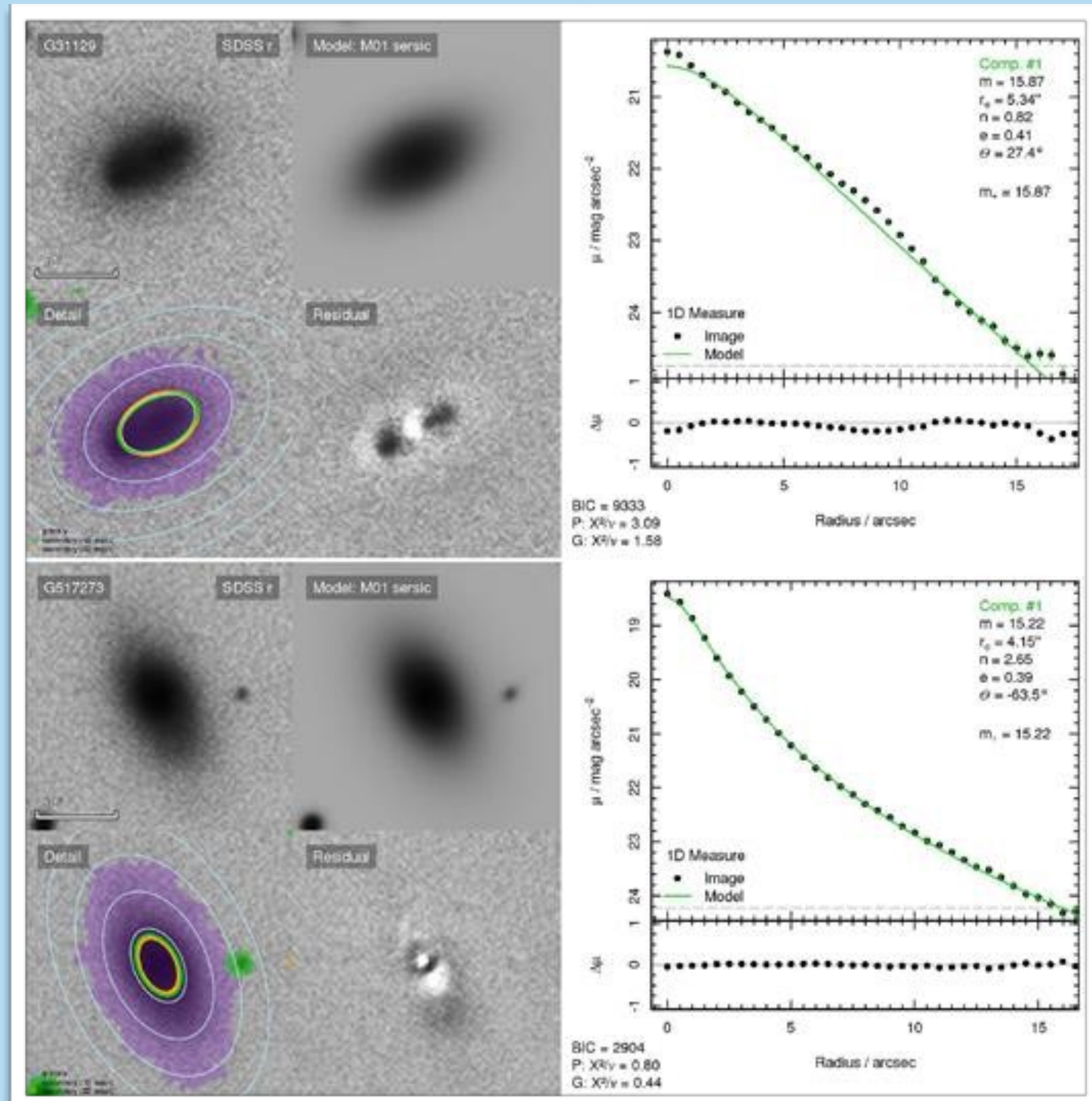


- Late-type and early-type galaxies form two different sequences
- BSphs seem to extend the relation followed by spirals to low luminosities

BSphs look like ellipticals but behave like spirals!

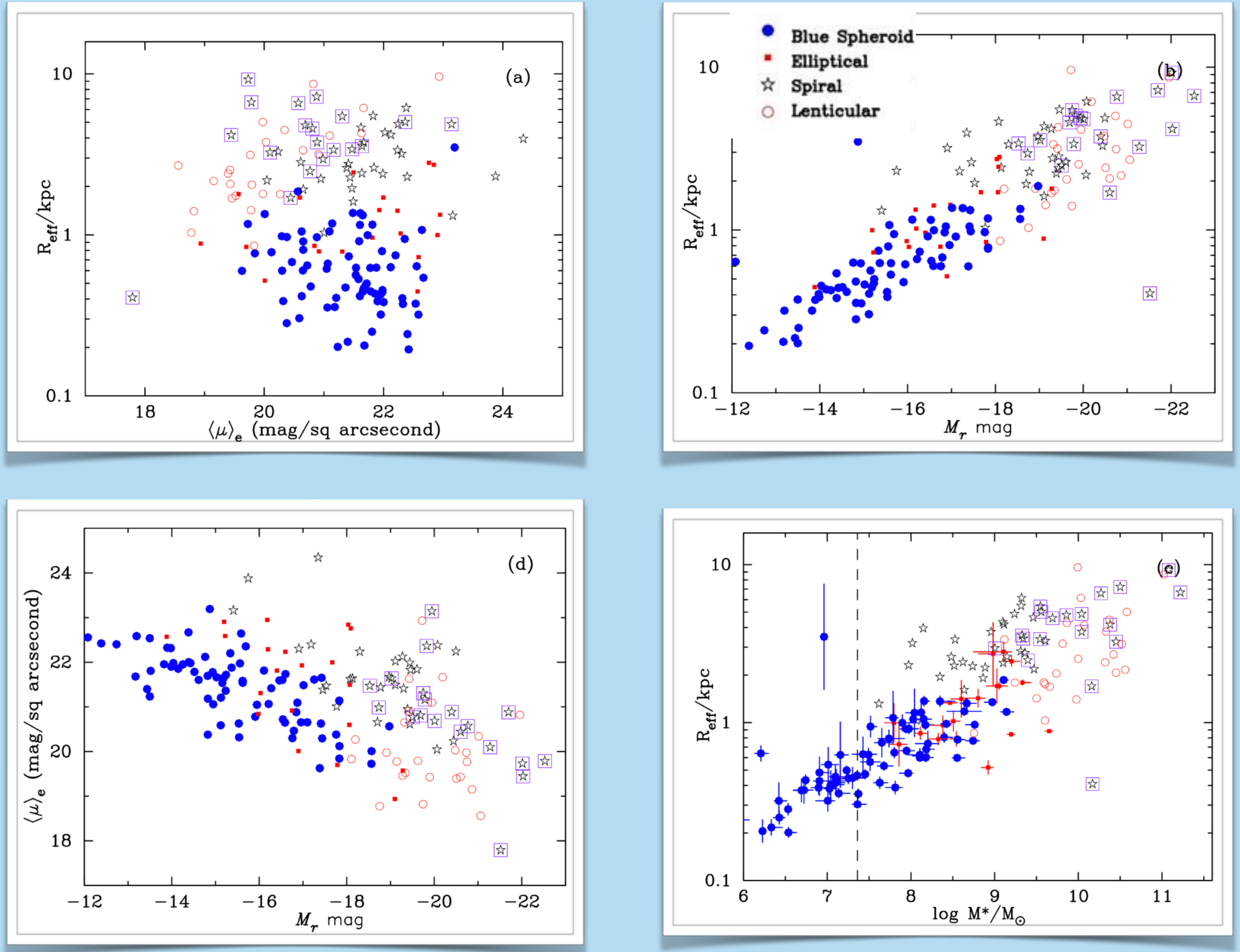
smritimahajan@iisermohali.ac.in

Quantifying morphology



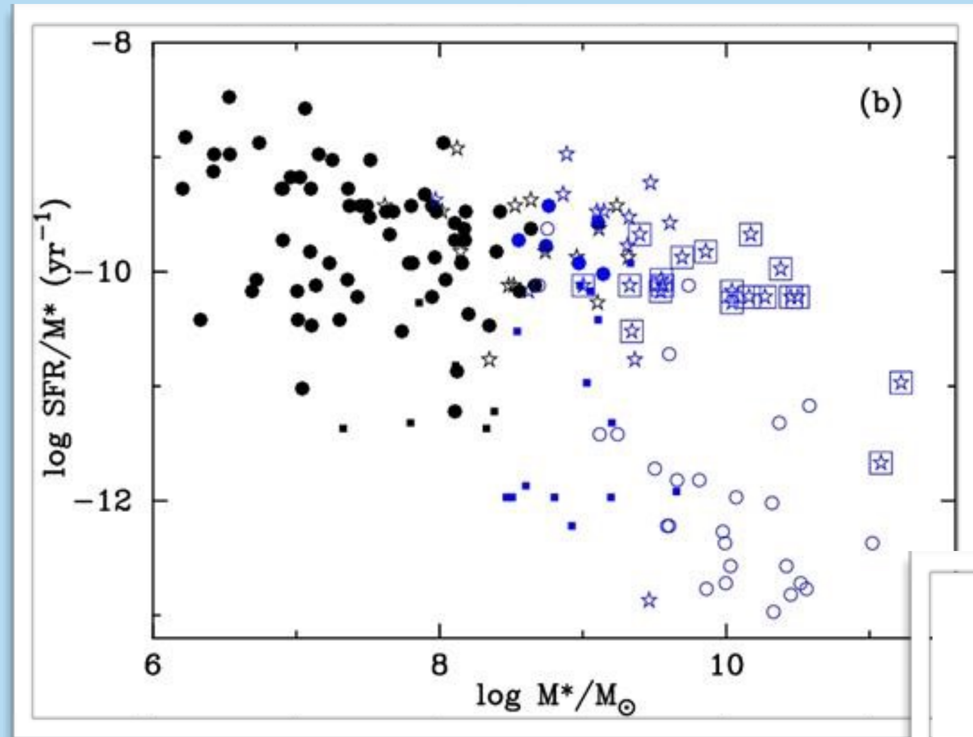
- Single component Sersic surface brightness fits done using SIGMA
- Output includes: R_{eff}, $\mu_{central}$, $\langle\mu\rangle$, M among others
- We use these parameters to quantify the trends in the morphology of different types of galaxies

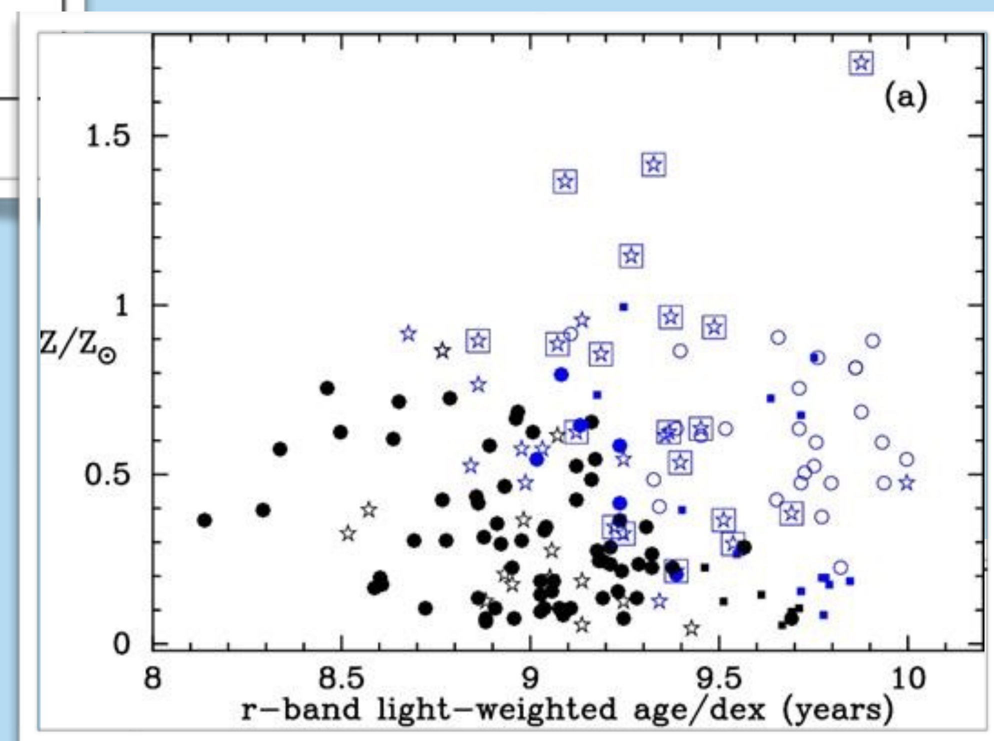
smritimahajan@iisermohali.ac.in

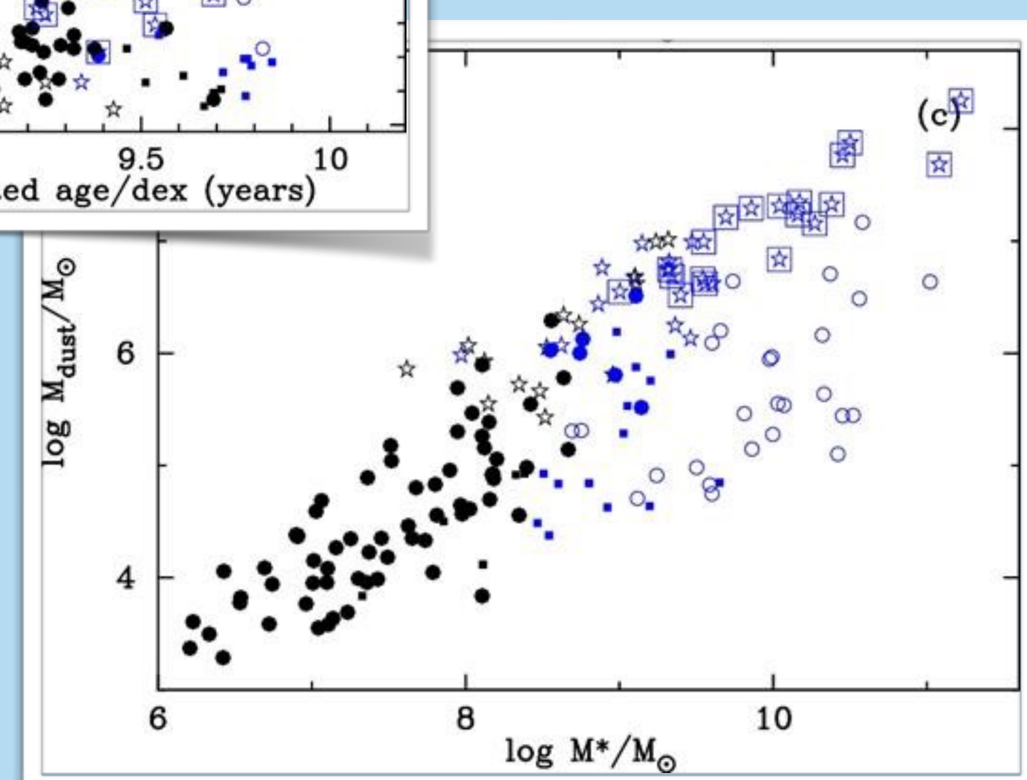


smritimahajan@iisermohali.ac.in

Clustering in multi-dimensional space



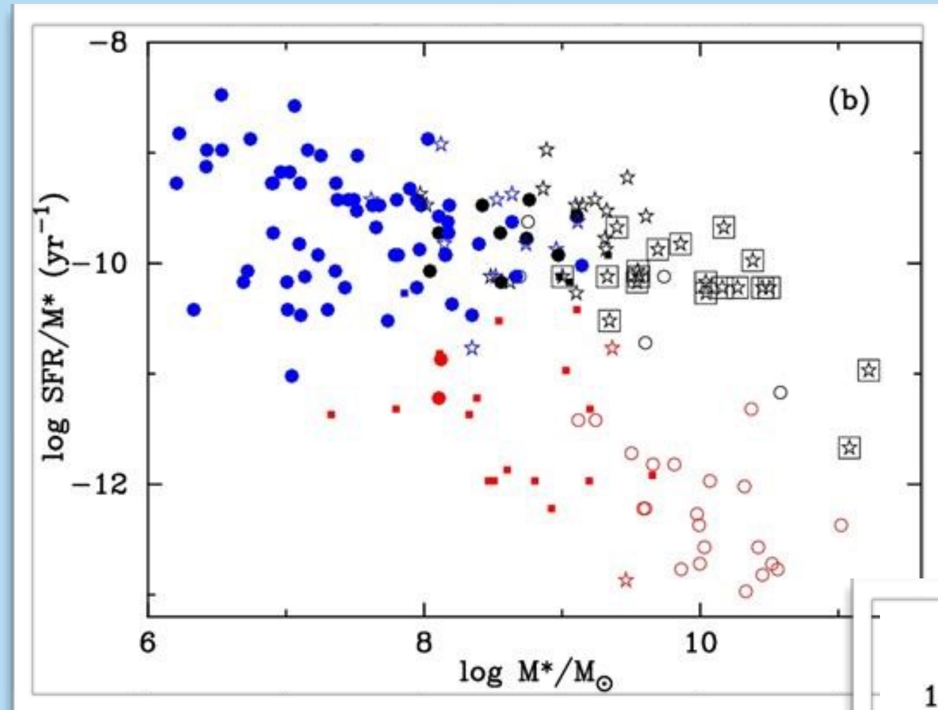


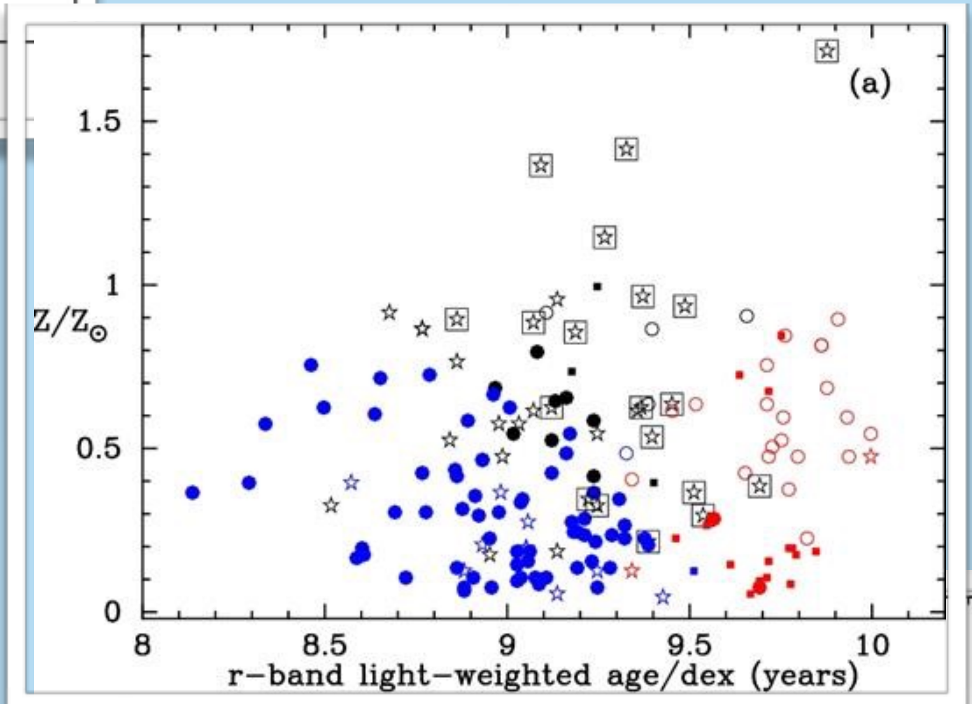


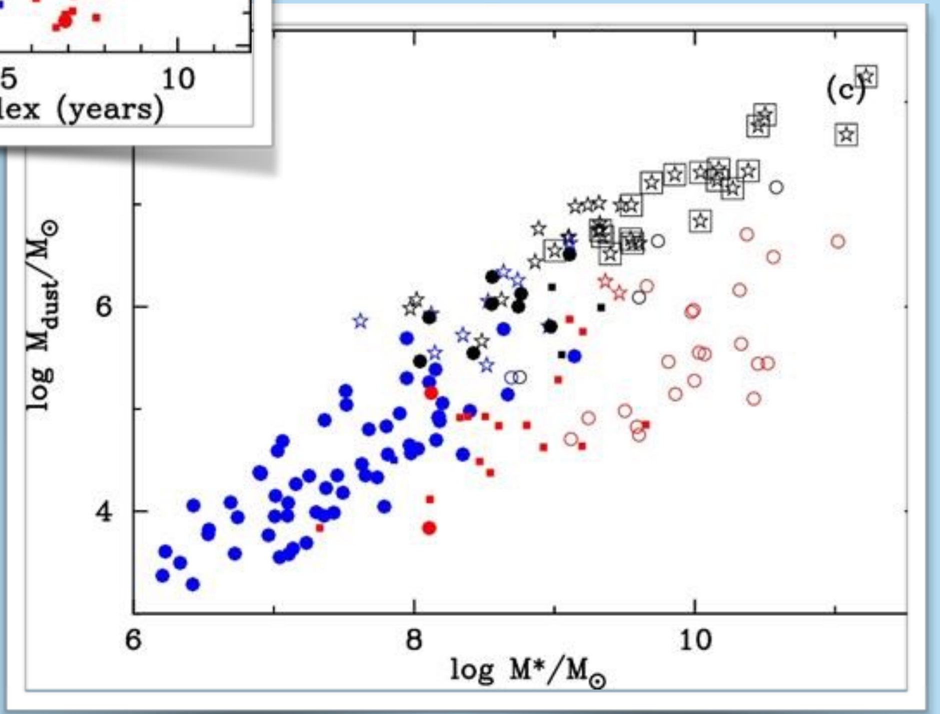
- We used the k-means algorithm to find “clusters” of galaxies in **age, Z and sSFR**.
- The algorithm showed a statistical preference for two clusters separating the dwarfs and the giant galaxies.

smritimahajan@iisermohali.ac.in

Clustering in multi-dimensional space

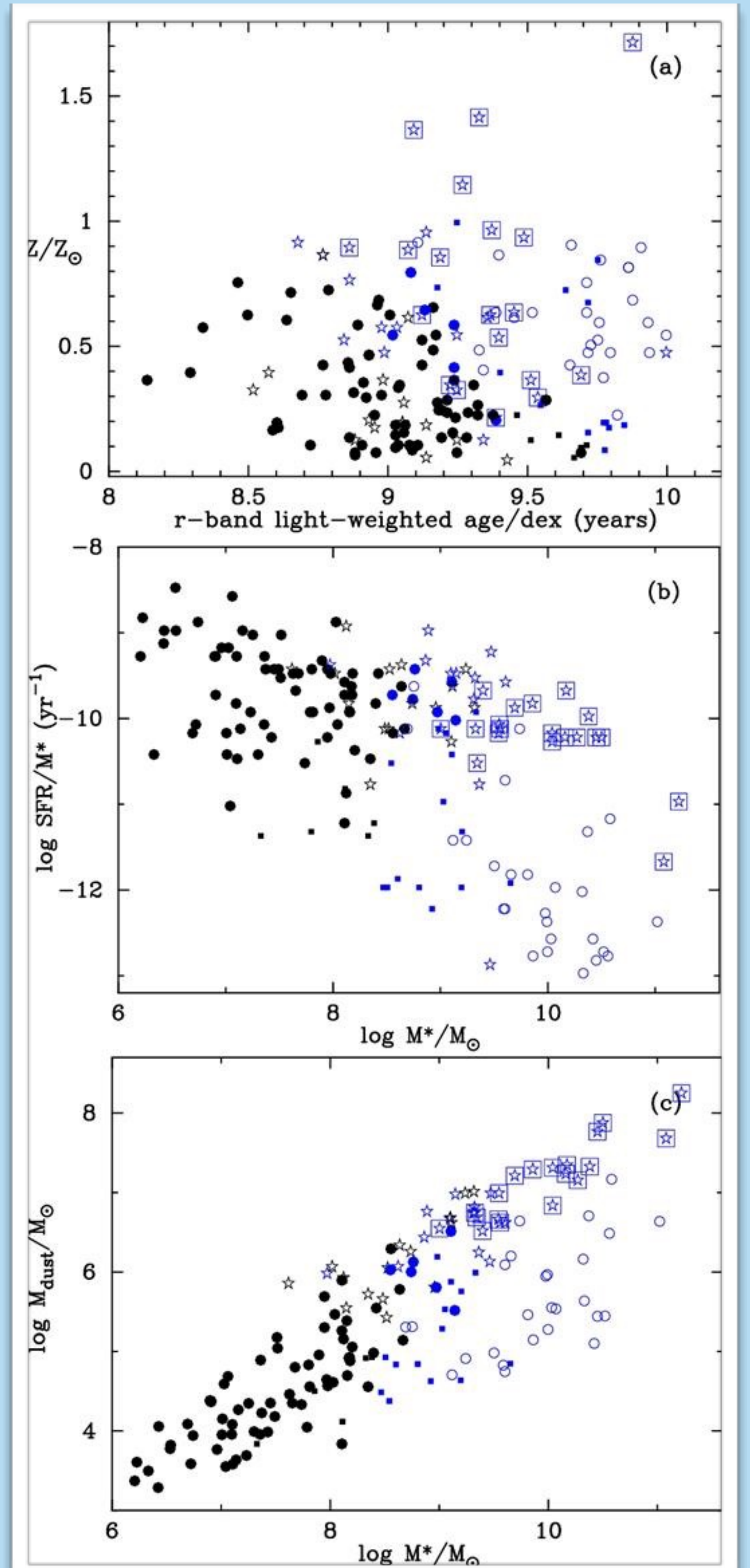


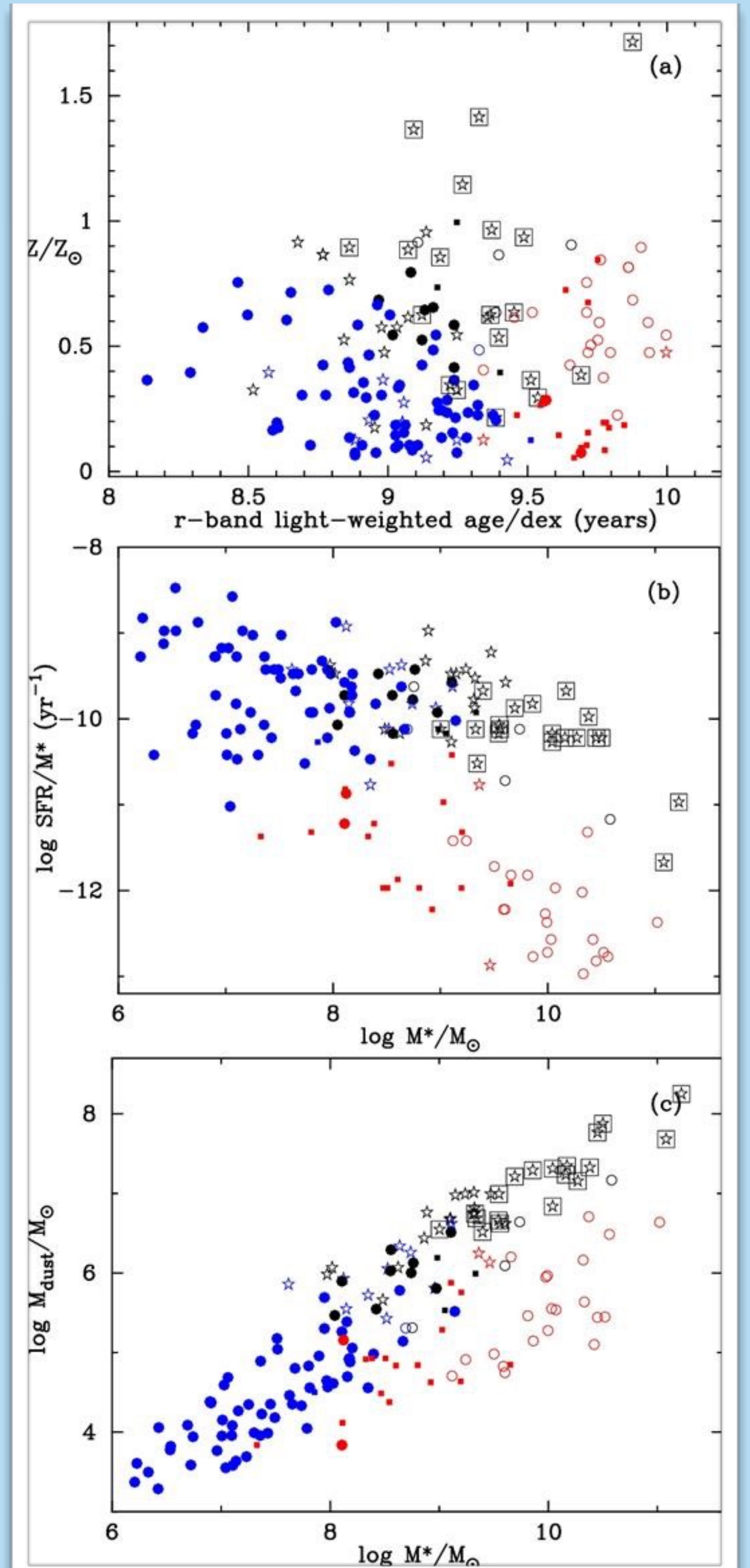




- Parameters used for clustering: **<u>age, Z, sSFR and M$_{dust}$</u>**.
- The algorithm now prefers 3 clusters instead of 2.
- Separate the massive galaxies into passive spirals and lenticulars.

smritimahajan@iisermohali.ac.in





smritimahajan@iisermohali.ac.in

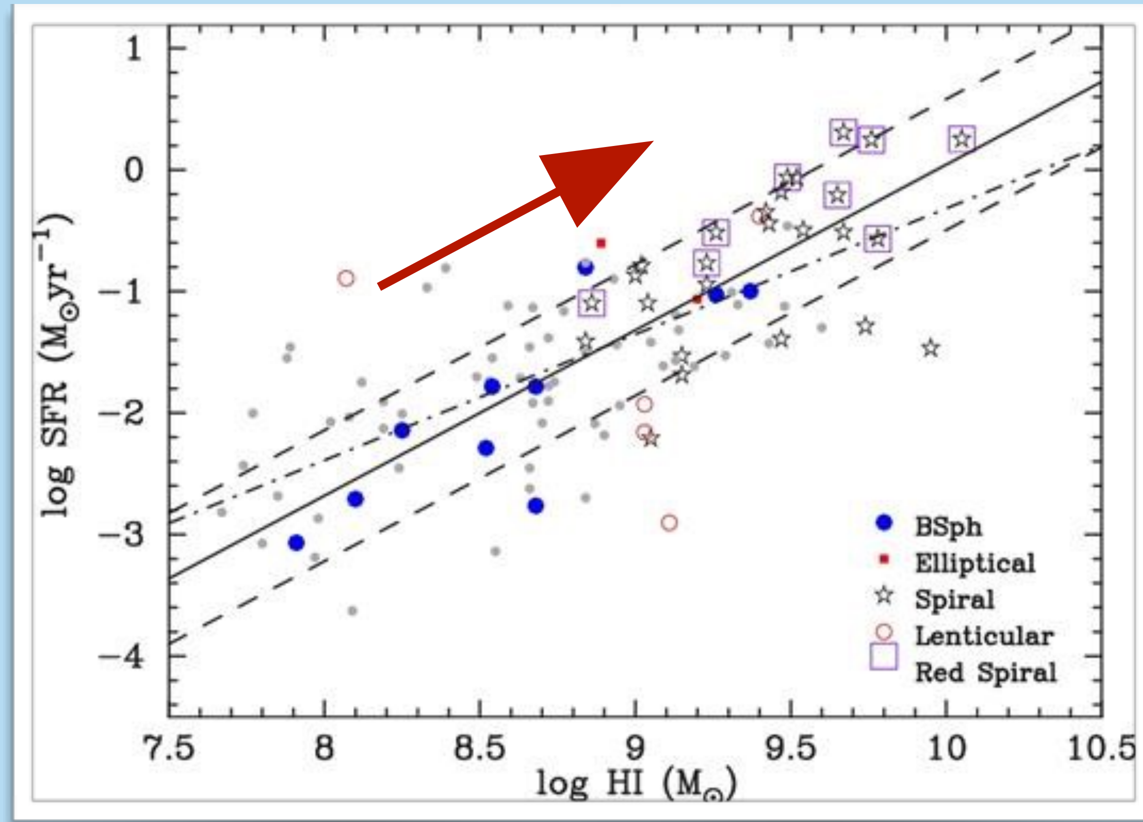
Automated classification results.

Analysis	Parameters	N_g	N_c	n_1	n_2	n_3	p_{bsph}	p_{other}
1	Age, Z, $M*$	165	2	88	77	–	92 per cent	24 per cent
2	Age, Z, SFR/M^*	165	2	120	45	–	97 per cent	41 per cent
3	Age, Z, SFR/M^*, M_{dust}	165	3	74	50	41	85 per cent	16 per cent
4	Age, Z, SFR/M^*, M_{dust}, $M*$	165	3	69	59	37	84 per cent	12 per cent

Notes.N_g is the number of galaxies in the sample, N_c is the preferred number of clusters, and n_i are the number of galaxies assigned to cluster *i*. p_{bsph} is the percentage of all visually classified BSph galaxies assigned to the first cluster and p_{other} is the percentage of all galaxies in the first cluster which were not classified as BSph.

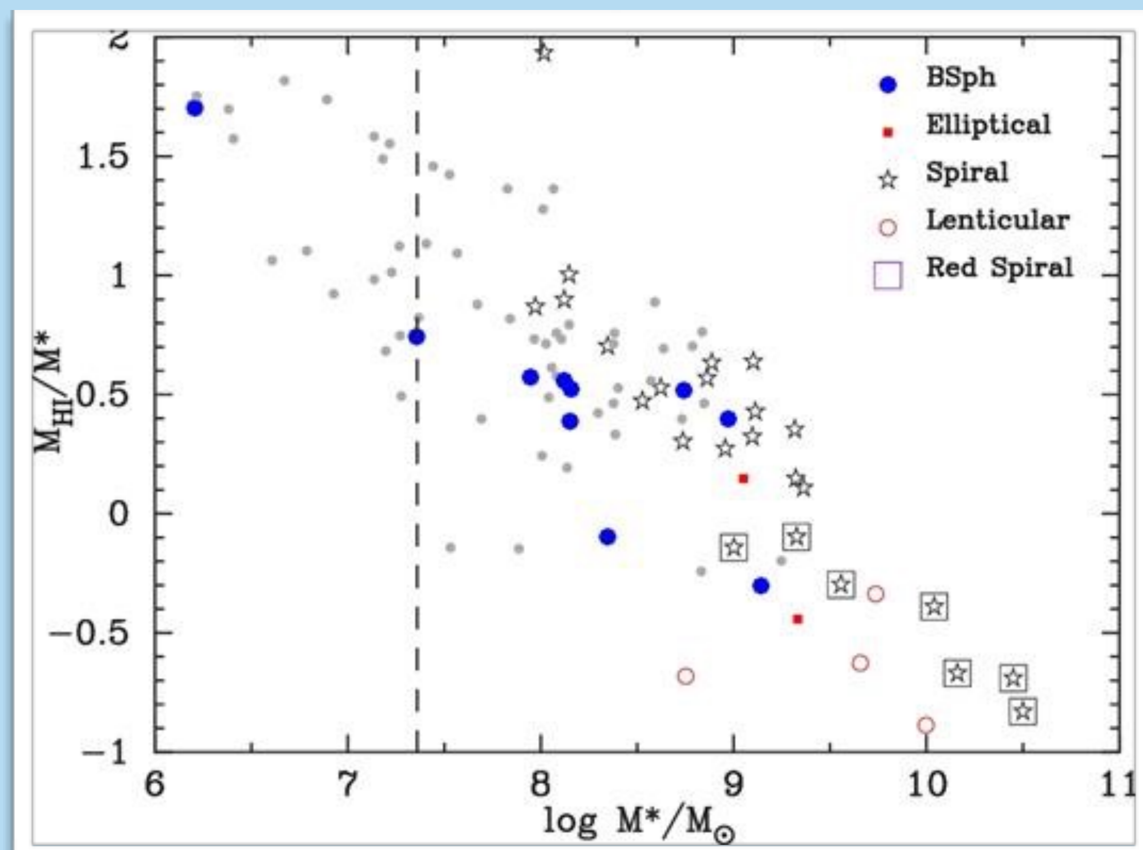
smritimahajan@iisermohali.ac.in

Gas in different types of galaxies



- The BSphs follow the same scaling relation between gas and SFR as the spiral galaxies.

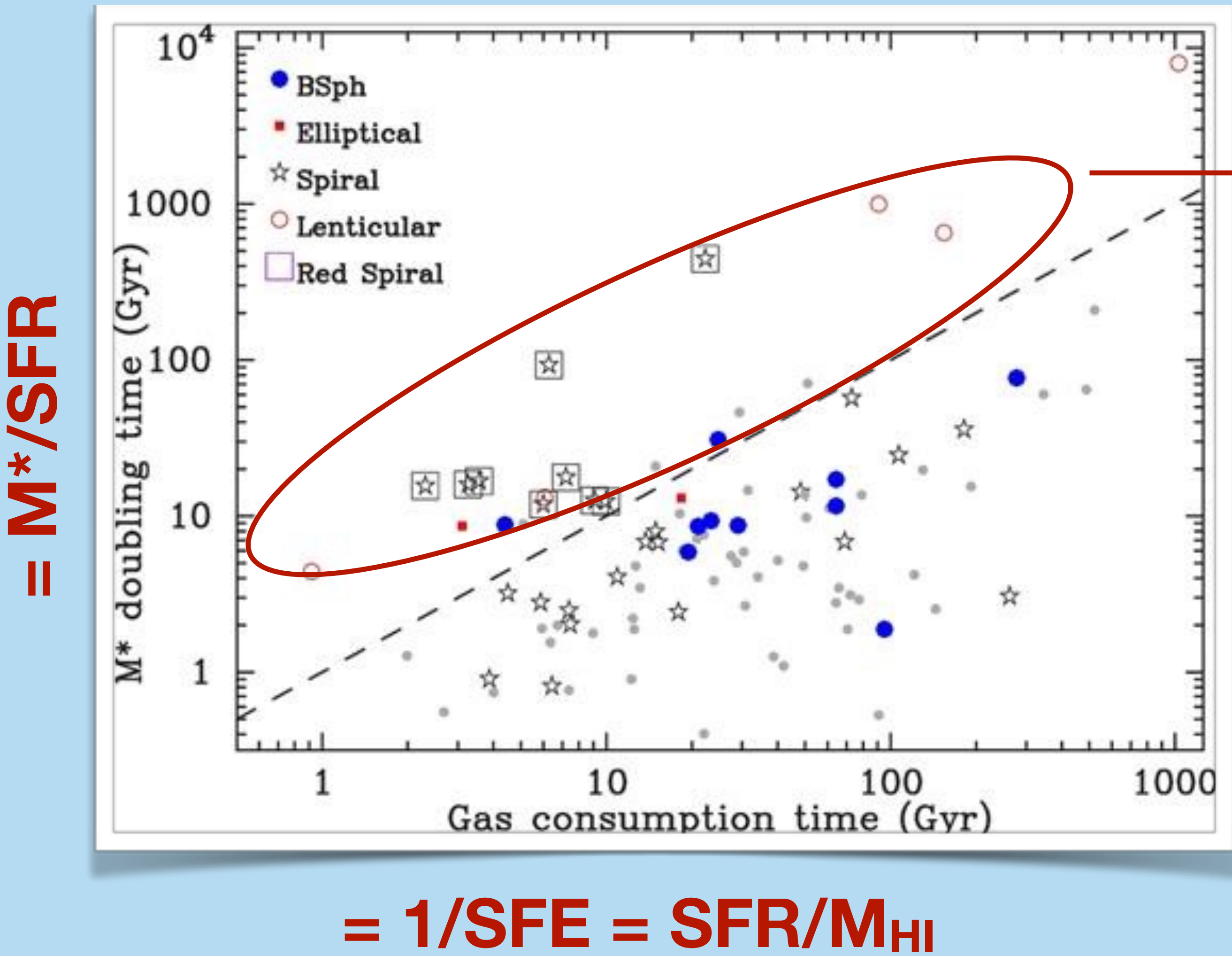
Even if the BSphs develop a disk in future and move towards right, they are likely to follow the same relation.



- The gas-to-stars ratio for BSphs vary by ~ 2 dex for our small sample, thus implying their evolution is very heterogenous.

smritimahajan@iisermohali.ac.in

The future of BSphs



Assumption: the unmeasured molecular gas mass in these galaxies is not very large, galaxies on the left of the line of equality cannot double their stellar mass without accreting new gas.

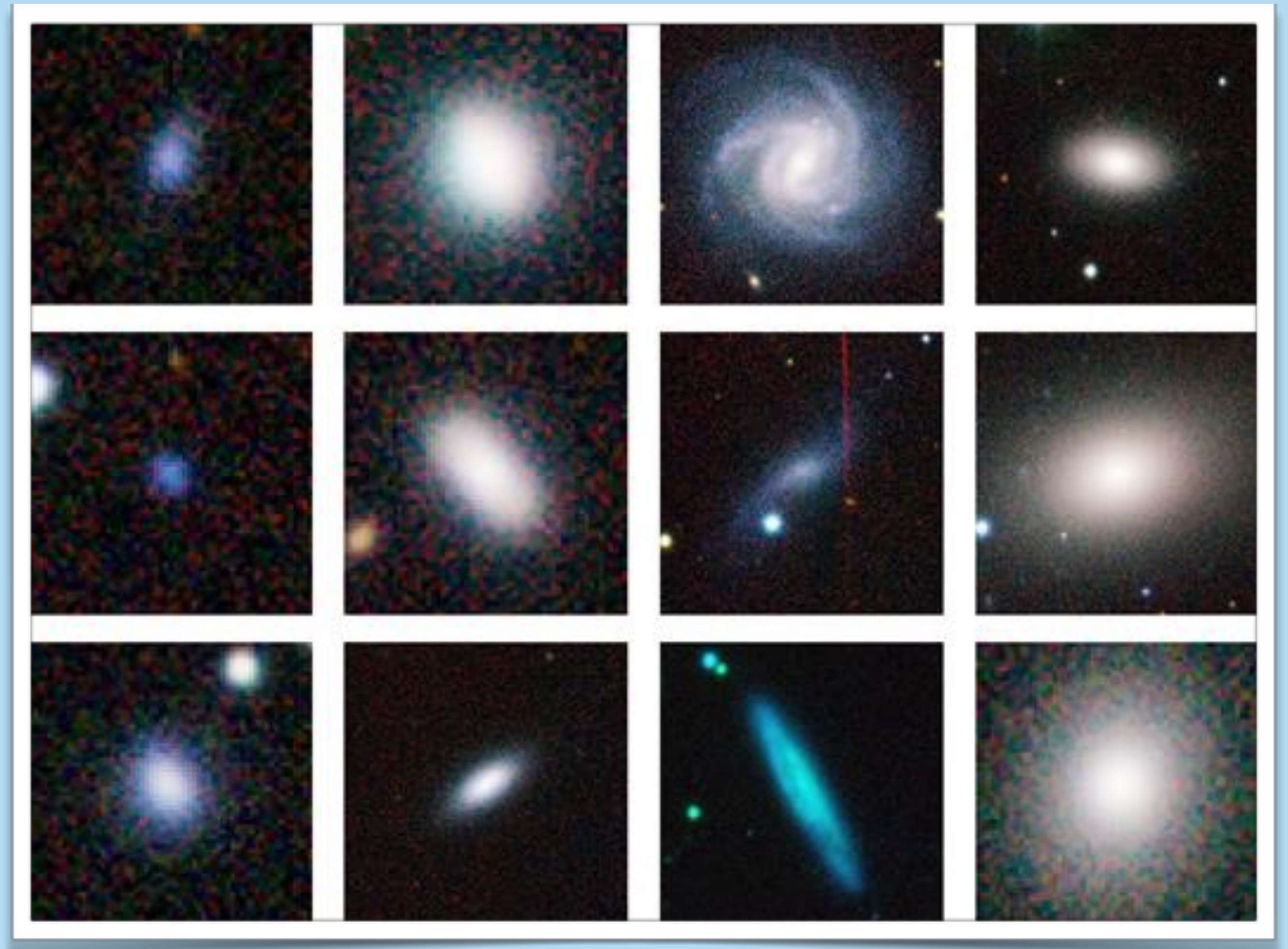
BSphs are less efficient at forming stars than spiral galaxies.

Most BSphs (8/10) can undergo significant evolution even in a closed-box scenario and therefore are likely to be morphologically transformed.

smritimahajan@iisermohali.ac.in

Conclusions

While **some BSphs may develop disks and turn into spirals in the future**, others in the low-density environments are likely to turn into red, passively-evolving elliptical galaxies. But **the current observable properties of BSphs statistically distinguish them from spirals as well as ellipticals**.



Mahajan et al., 2018, MNRAS, 475, 788

smritimahajan@iisermohali.ac.in

Summary

- BSphs are structurally very similar to ellipticals, but the distribution of their age, Z, M_{dust}, and sSFR is more like the star-forming spirals than the passively evolving spheroids (ellipticals or lenticulars).
- BSphs follow the same SFR– M_{HI} and M_{HI}–M^* scaling relation as the spirals.
- BSphs have lower Star Formation efficiency than spirals.
- The automated clustering algorithm k-means applied to the multi-dimensional parameter space mapped by age, Z, and M^* decomposes the spheroids and spiral galaxies into two ‘clusters’. The larger of these comprises 92 per cent of the BSphs but is heavily contaminated (24 per cent) by other types of galaxies having low age, Z, and M^*.
- The low-mass galaxies, must have infall-regulated supply of gas. Their future is therefore likely to depend on environment: BSphs in the low-density region can accrete more cold gas, therefore developing an intermediate- or large-scale disc, while those in the high-density environment are prone to more lumpy accretion building an elliptical galaxy. A bit of both the processes is likely to result in a low-mass lenticular.

smritimahajan@iisermohali.ac.in

Broadband spectral and timing studies with AstroSat, Chandra and XMM-Newton

A COSPAR Capacity Building Workshop

March 9-20, 2019

IISER, Indian Institute of Science Education and Research,
Mohali, Punjab, India.

Main Menu

- Home
- Description
- Program
- Information
- Application
- Gallery
- Contact

The primary aim of the workshop is to train scientists in the middle and south East Asian region in using AstroSat's multiwavelength spectral and timing capabilities and teach them how to use these capabilities in conjunction with data from Chandra and XMM-Newton.

AstroSat was successfully launched on September 28th 2015. It is a complex mission consisting of four co-pointing instruments and an all sky monitor. The Ultra-violet imaging telescope (UVIT) can observe in three bands and has a wide field of view (~28') and an angular resolution of ~1.5". The Soft X-ray Telescope (SXT) provides energy spectra information in the 0.3 – 7.0 keV band. The Large Area X-ray Proportional Counters (LAXPC) are able to do fast timing (10 microseconds) analysis and moderate spectral analysis of X-rays in the 3-80 keV band. The Cadmium Zinc Telluride Imager (CZTI) give good spectral information in the 25 to 100 keV band.

The workshop will be attended by around 40 young scientists from the Asian/Middle East region who will be given lectures and demonstrations by experts on data analysis of all the instruments on board AstroSat, Chandra and XMM-Newton, as well as the science that can be extracted. The participants will also do a small project involving more than one instrument with the help of experts. Chandra and XMM-Newton are well-established missions, and hence data are already available, instrument calibration is mature, and analysis software is available. We expect that, by the time of the workshop, the instruments on board AstroSat will be well characterized and the data analysis and the corresponding software would be streamlined. The aim will be to build the foundation for optimal use of AstroSat data by the regional community.