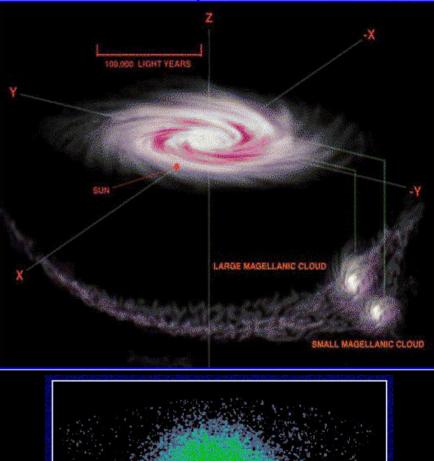
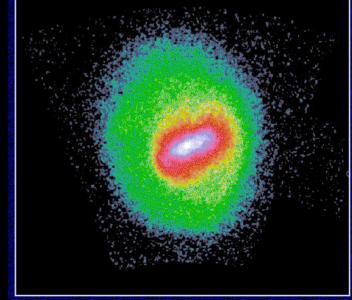
# Large Magellanic Could: New Puzzles of the disk and halo

Annapurni Subramaniam

## Introduction

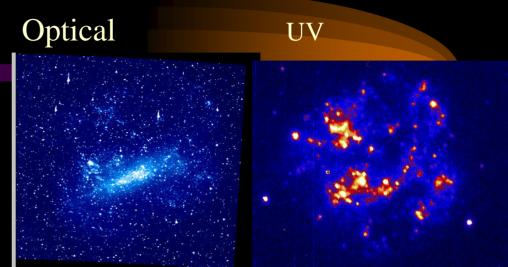
- LMC, SMC and Milky Way are known to have had close encounters. Interaction of the Milky Way with the Magellanic Clouds creates tidal forces which could alter the structure of the clouds.
- DENIS and 2MASS survey of the LMC found evidences of tidal forces on the outer LMC. SMC, on the other hand is known to show these signatures.



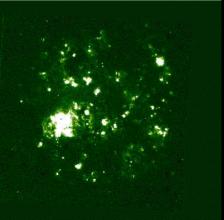


#### The so-called bar of the LMC

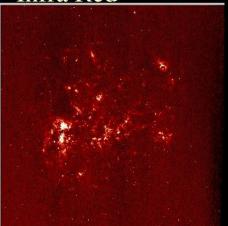
- The bar of the LMC, is found to be peculiar from the following arguments:
- The bar does not seem to drive any prominent spirals.
- The colour of the bar is found to be red, indicating that the recent star forming regions are not located on the bar and are also not driven by the bar.
- The bar is offset from the center and is asymmetric.
- The H I gas distribution does not show the signature of the bar.



Ηα



Infra Red



#### LMC – field CMD

22

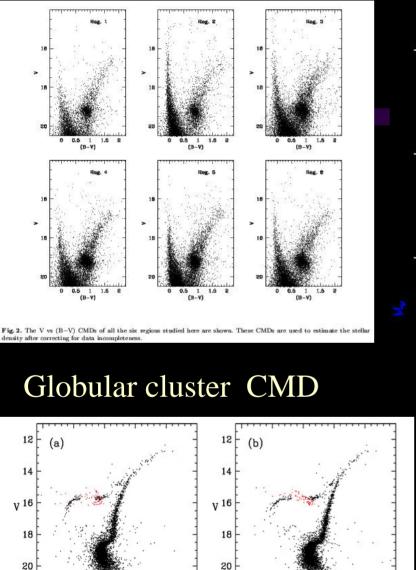
-0.5

0

0.5

B-V

#### Synthetic CMDs



22

-0.5

0

0.5

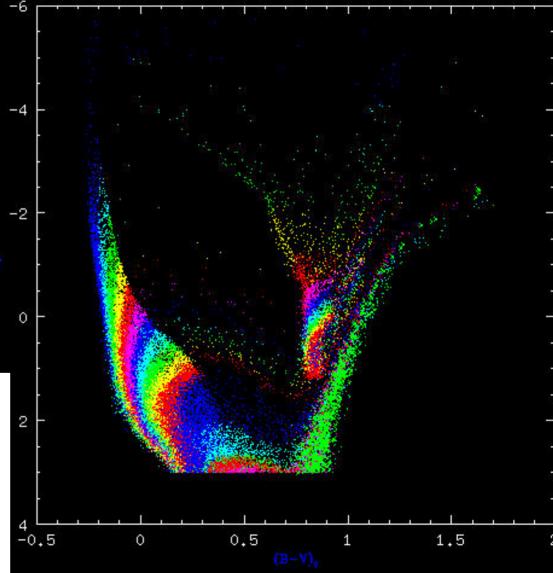
V-I

1.5

2

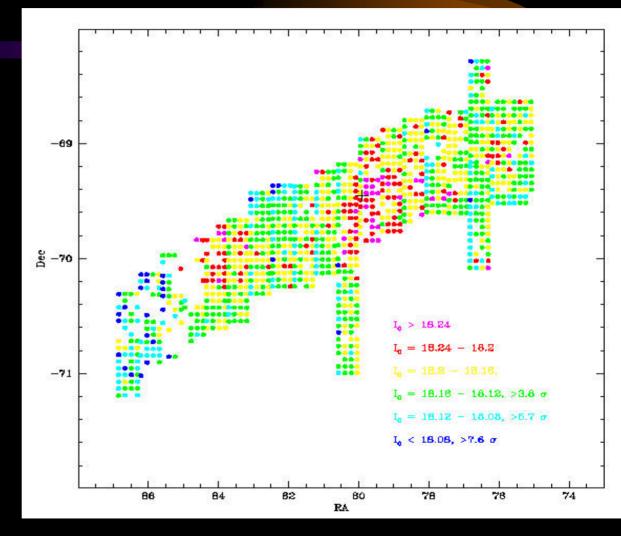
1.5

2



### 2-D distribution of red clump magnitudes

- Thus the bar is not expected to show any variation in I<sub>0</sub>, above the estimated error.
- Surprisingly, the bar region showed variation in I<sub>0</sub>.



#### Variation of magnitude along the RA axis

- We see an M-type variation. This indicates that the bar is warped.
- . These indicate that the bar is dynamically perturbed.

LMC bar: Evidence of a warped bar ; Annapurni Subramaniam, 2003, ApJ, 598, L19

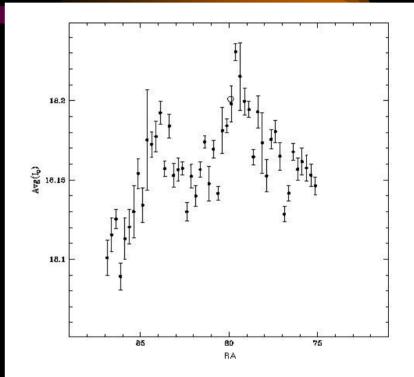
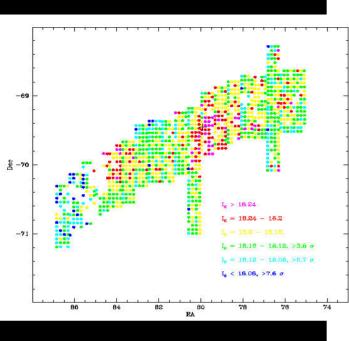


Fig. 4.— The average of the  $I_0$  along the declination is estimated for various RA and the value  $avg(I_0)$  is shown against RA. The error indicates the scatter in  $I_0$  along the declination. The open circle shows the location of the center of LMC.



•Evidence of a misaligned secondary bar in the Large Magellanic Cloud; Annapurni Subramaniam, 2004,

ApJ, 604, L41

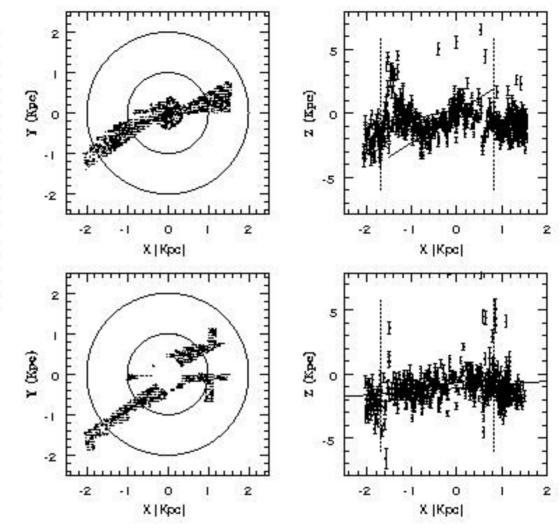


Fig. 2.— The location of the primary bar within the  $PA = 110^{\circ}.0 \pm 12^{\circ}.0$  is shown in the X-Y and X-Z plane in the top panel. The location of the rest of the bar in the X-Y and X-Z planes are shown in the bottom panel. The circles in the left figures are drawn at 1°.0 and 2° radii. The filled circles in the left panel indicate points which have Z > 0.0. The dotted lines shown in the right figures correspond to locations showing change in density profiles. The errors in the data points are obtained from Subramaniam (2003), where the  $\Delta I_0$  values are converted to Kpc as explained in the text.

- The position velocity diagrams along four values of position angles (PA) are shown. It can be seen that near the center, the slope is reversed, indicating the presence of counter rotation.
- The location of the secondary bar and the counter rotating core are similar.
- This could be the kinematic evidence of the secondary bar.

### Kinematic signature

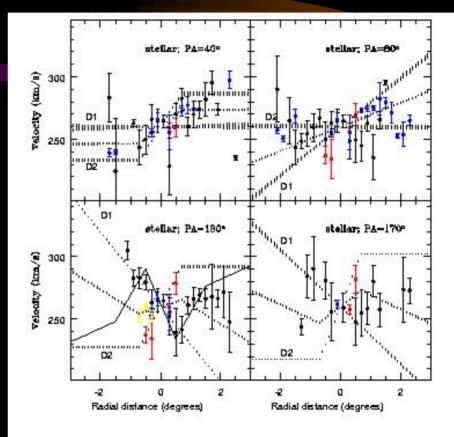
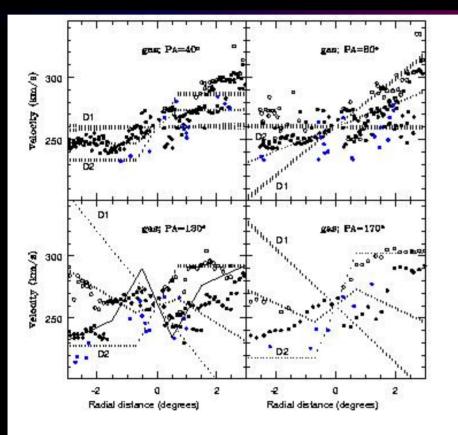
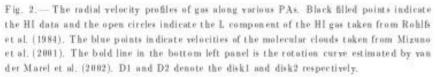


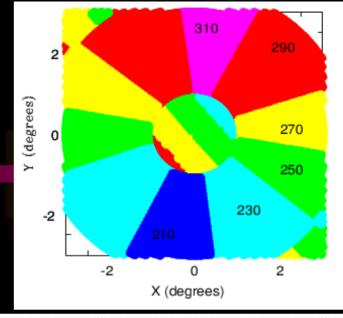
Fig. 1.— The radial velocity profiles of stars along various PAs. Black points indicate stellar velocities of Zhao et al. (2003), red points indicate carbon star velocities from Kunkel et al. (1997), blue points indicate velocities of red super giants from Olsen & Massey (2003) and yellow points indicate velocities of red giants from Cole et al. (2004). The bold line in the bottom left panel is the rotation curve estimated by van der Marel et al. (2002). D1 and D2 denote the disk1 and disk2 respectively.

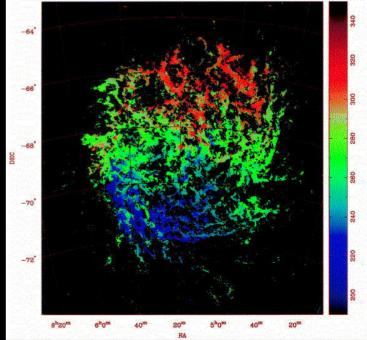
#### **Kinematics of HI gas in the LMC**

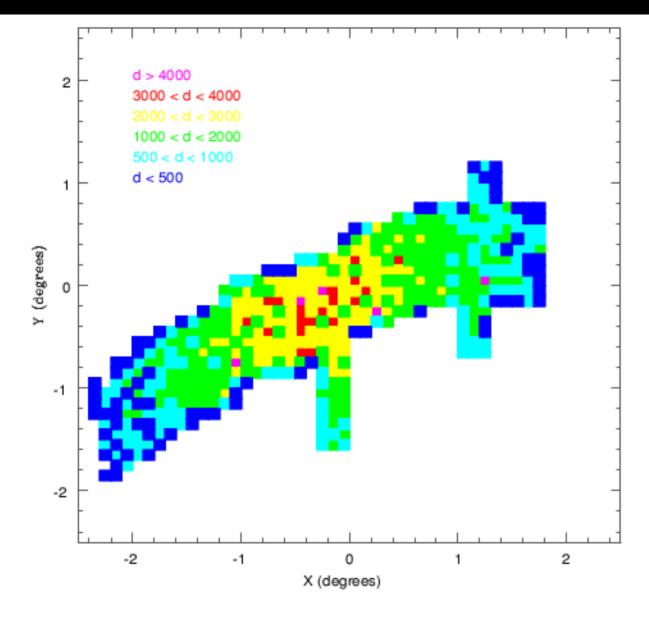
Evidence of a counter rotating core in the LMC; Annapurni Subramaniam & T.P. Prabhu, 2005, ApJ, 625, L47











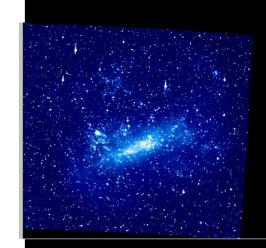


Fig. 1. Number density distribution of RR Lyrae stars in the LMC. The unit for the number density, d is stars/sq. degree. The colour code is explained in the figure, where magenta denotes locations of highest density and blue denotes locations of lowest density.

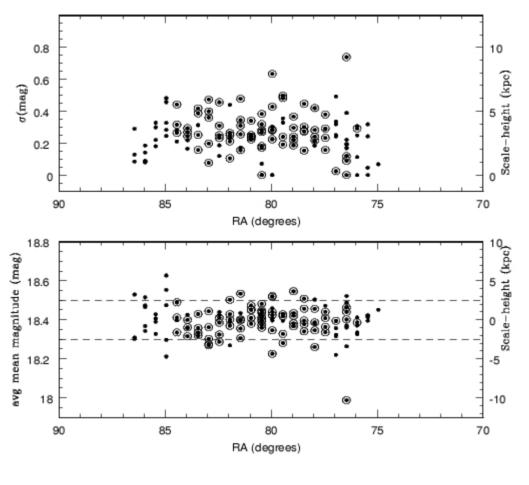


Fig. 7. The variation of  $\sigma_{(dep)}$  (upper panel) and scale-height (lower panel) as a function of RA. Locations with number of stars more than 10 are shown as dots and those with more than 30 stars are shown with circles around them.

Results are published in: RR Lyrae stars in the inner LMC: halo-like location and disk-like Distribution; Annapurni Subramaniam, 2006, A&A, 449,101

## Recent results on the Disk+ Halo

- We obtained observations of the LMC outer regions using the CTIO 4.0m Blanco telescope (October 2005) – proposal to reveal the LMC halo.
- Four nights were allotted two were clear.
- Preliminary results are presented here.
- Similar observations are planned for the coming season as well.
- Collaborators: Abhijit saha (NOAO), Nicholas Suntzeff (Texas A&M), Ed Olszewsky (Arizona), Knut Olsen (NOAO)

