

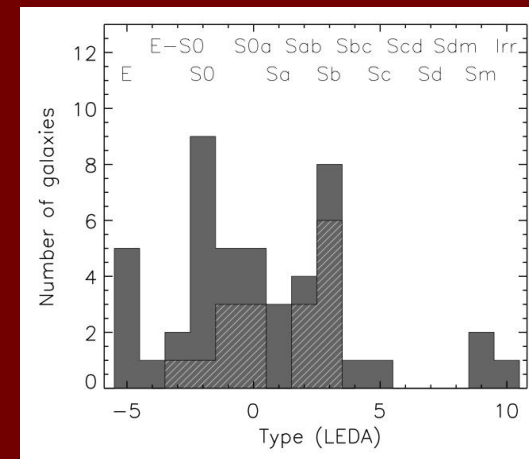
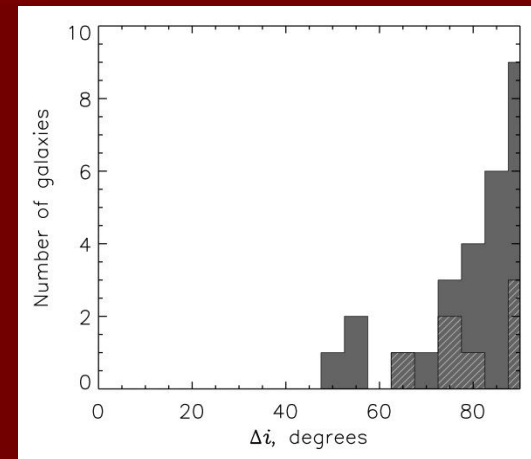
# Inner polar ionized-gas disks and properies of their host galaxies

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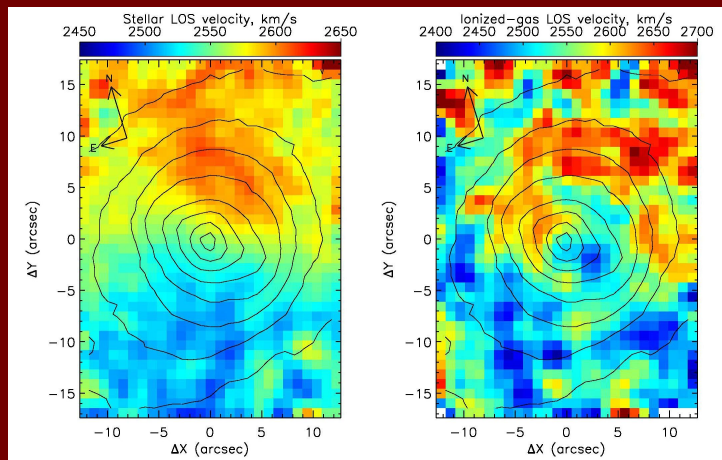
# Inner polar disks, what is it?

- Gaseous (mostly ionized-gas), regularly rotating disks
- with radii of 0.2-2 kpc,
- highly inclined to the galactic planes – by 50-90 deg.
- Recently a totality of 47 objects are reviewed by Moiseev (2012) – see here [histograms from this review](#).
- Mostly in S0-Sb, but there are some known cases in Es and very late-type galaxies



# 3D-kinematical diagnostics

- By applying a tilted-ring analysis to the stellar and gaseous LOS velocity fields, we obtain the parameters of the spatial orientations of their rotation planes – inclinations  $i$  and line-of-nodes position angles PA.
- The mutual inclination angle is calculated as following:  
$$\cos \Delta i = +/\pm \cos(\text{PA}_* - \text{PA}_{\text{gas}}) \sin i_* \sin i_{\text{gas}} + \cos i_* \cos i_{\text{gas}}$$



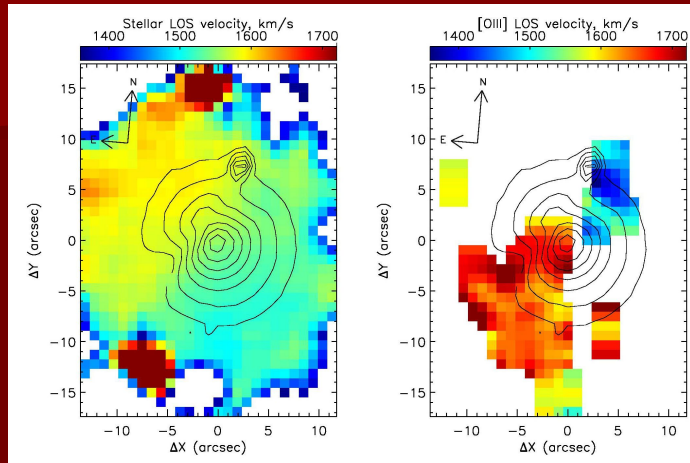
$\Delta i = 45$  or  $80$  deg

NGC 5850: the inner polar disk was firstly found by Moiseev et al. (2004); now how as it is seen by the SAURON

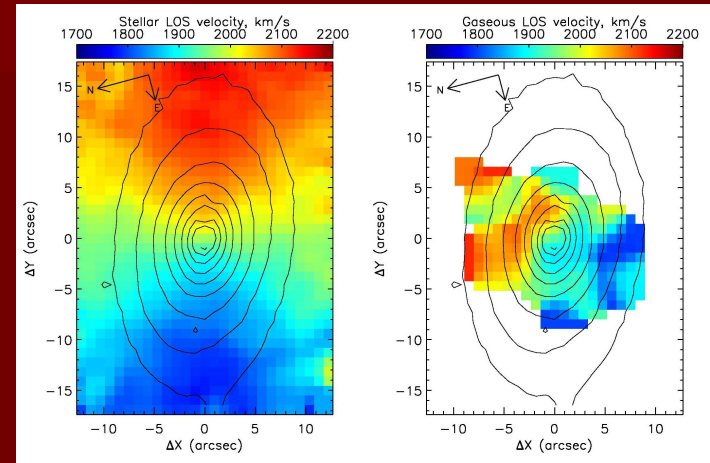
# The full sample of nearby S0 galaxies from the survey ATLAS-3D

- Raw SAURON data for the observations of 2007-2008 were retrieved from the ING CASU Astronomical Data Centre of Cambridge (UK) after the proprietary period.
- 149 S0 galaxies are selected where emission lines do not dominate over the whole fields of view.
- The LOS velocity fields are calculated for the stellar and ionized-gas (when present) components.
- The Lick indices  $H\beta$  , Mgb, and Fe5270 are also measured and properly calibrated. By applying the stellar population (SSP) models by Thomas et al. (2003), the ages, metallicity, and Mg/Fe radial profiles are derived.

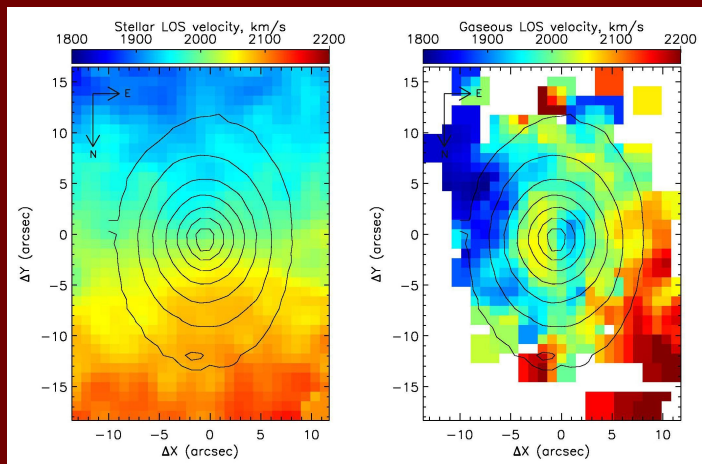
# More 8 inner quasi-polar ionized-gas disks are found in the S0 sample of the ATLAS-3D



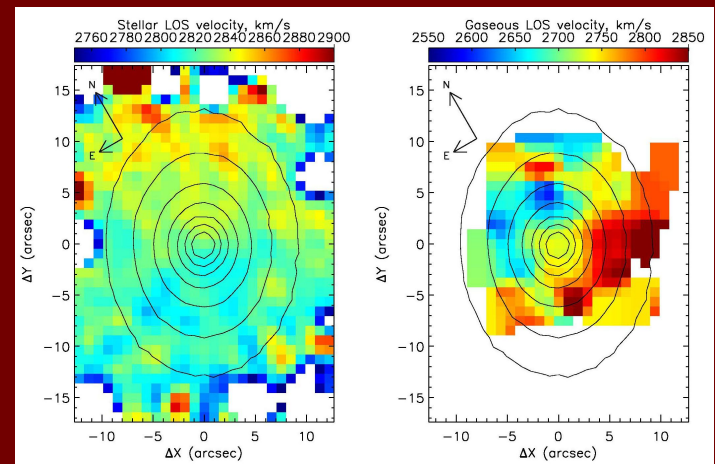
NGC 3499, inclined by 61/68 deg



NGC 3648, inclined by 68/88 deg

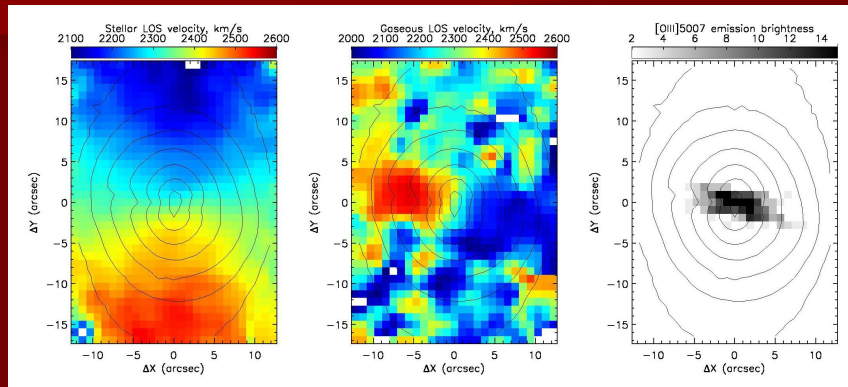


NGC 2962, inclined by 50/114

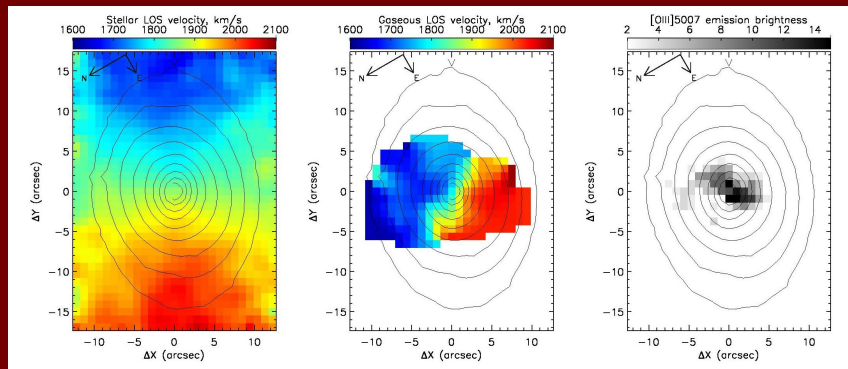


NGC 4690, inclined by 64/68 deg

# Sometimes, if the polar gaseous disk is edge-on, it is seen 'by eye'



NGC 4233



NGC 5507

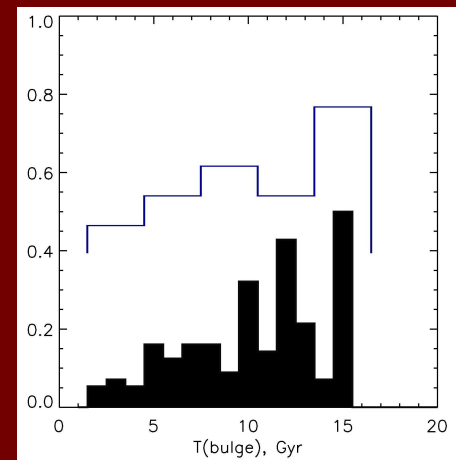
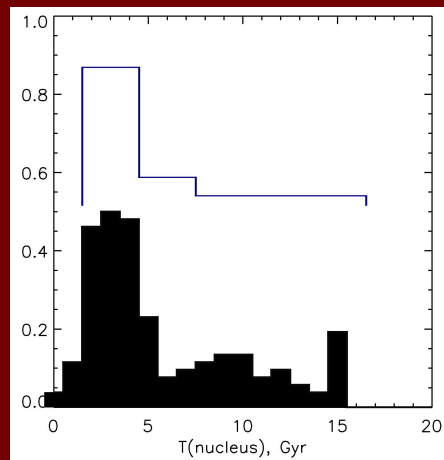
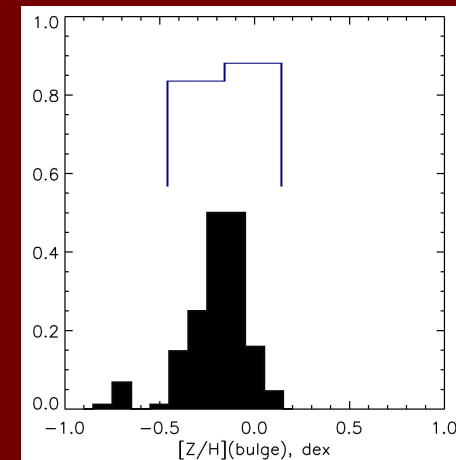
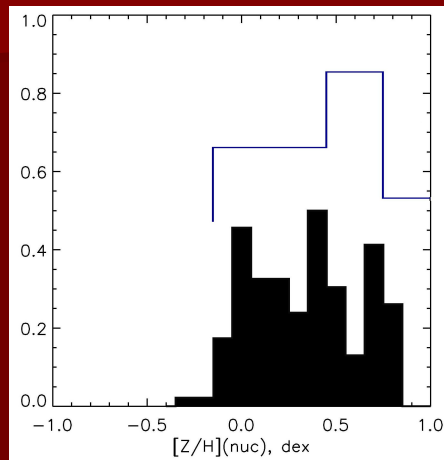
- Two S0 galaxies from the ATLAS-3D, where the distribution of the [OIII]5007 emission-line brightness gives a view of the edge-on polar disks.

# Incidence

- Among 149 S0s observed by the ATLAS-3D project in 2007-2008, 13 S0s have inner polar disks (together with the previously known ones).
- Among the full number of 200 S0s observed by the SAURON from 1999 to present, 20 S0s have inner polar disks.
- So if we consider this sample as a volume-limited one, the frequency of inner polar disks is **9%-10% of all nearby S0s.**



# Comparison of the host galaxies SSP properties in the ATLAS-3D sample



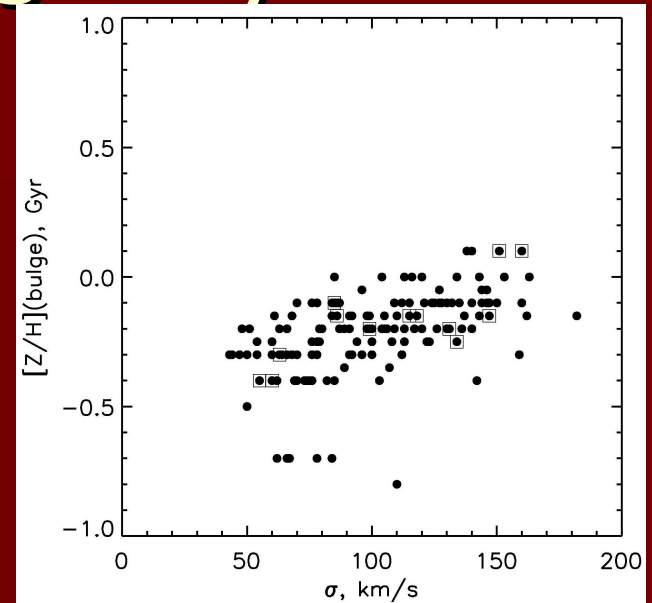
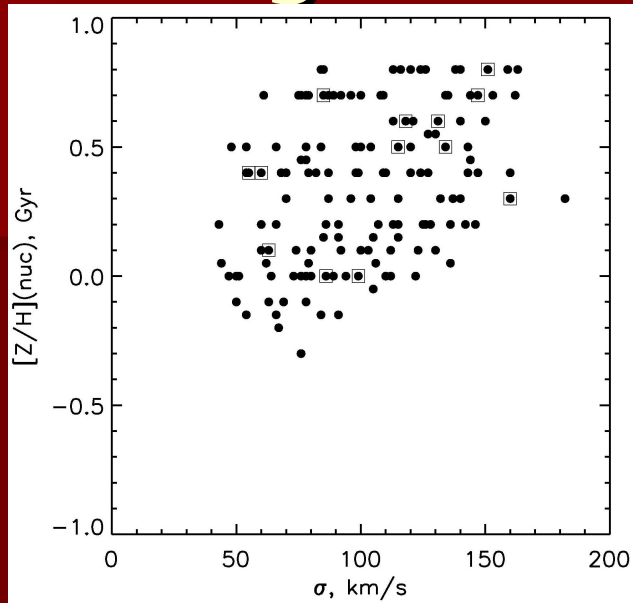
Filled black histograms – all the 149 S0s from the ATLAS-3D, blue-lined histograms – the host S0s of the inner polar disks.

Nuclei

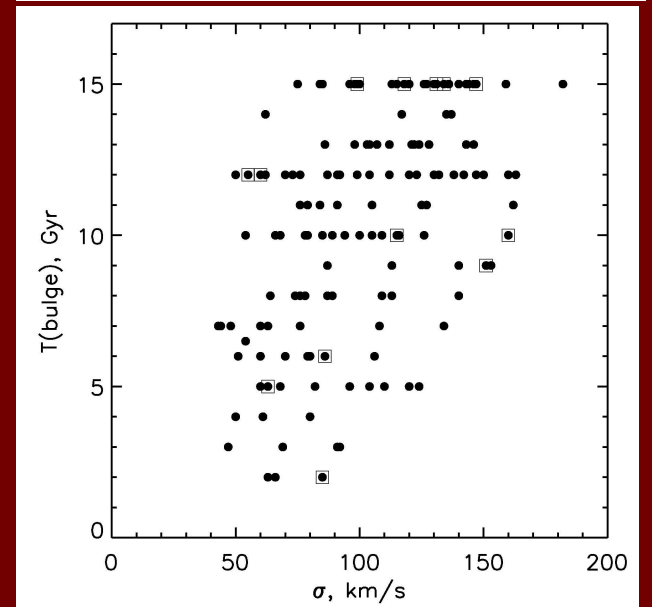
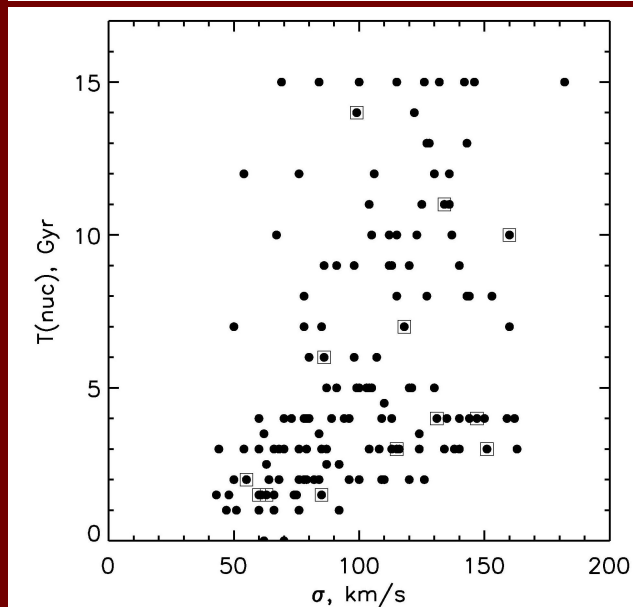
Bulges ( $R=4''$ - $7''$ )



# A range of the host galaxy masses



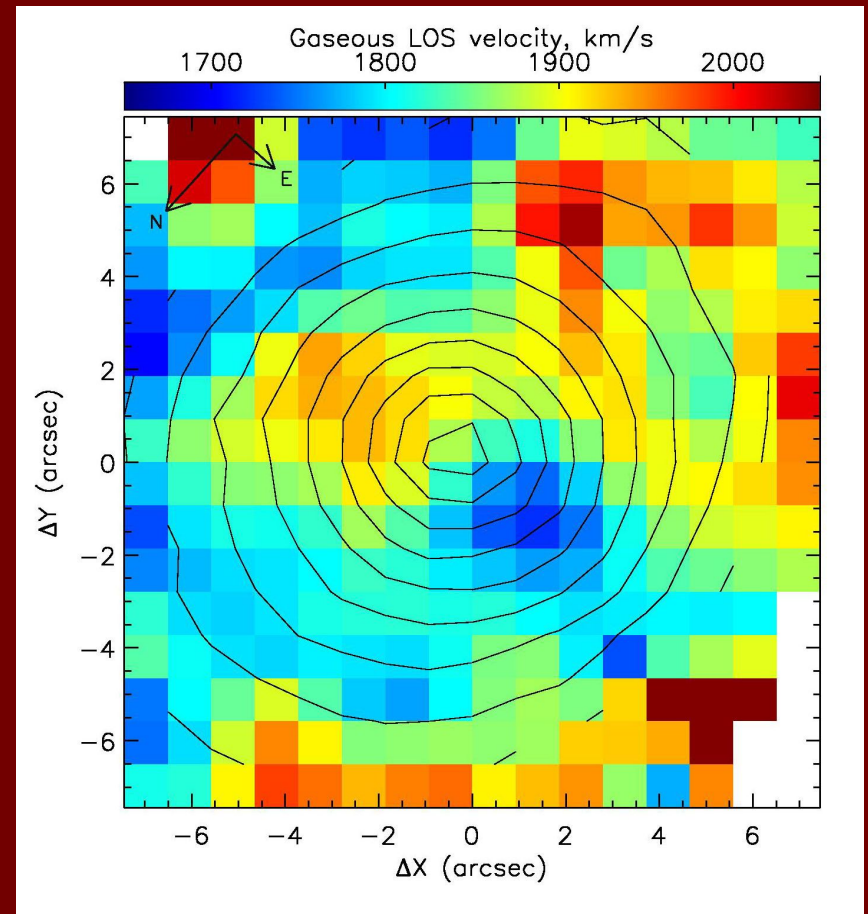
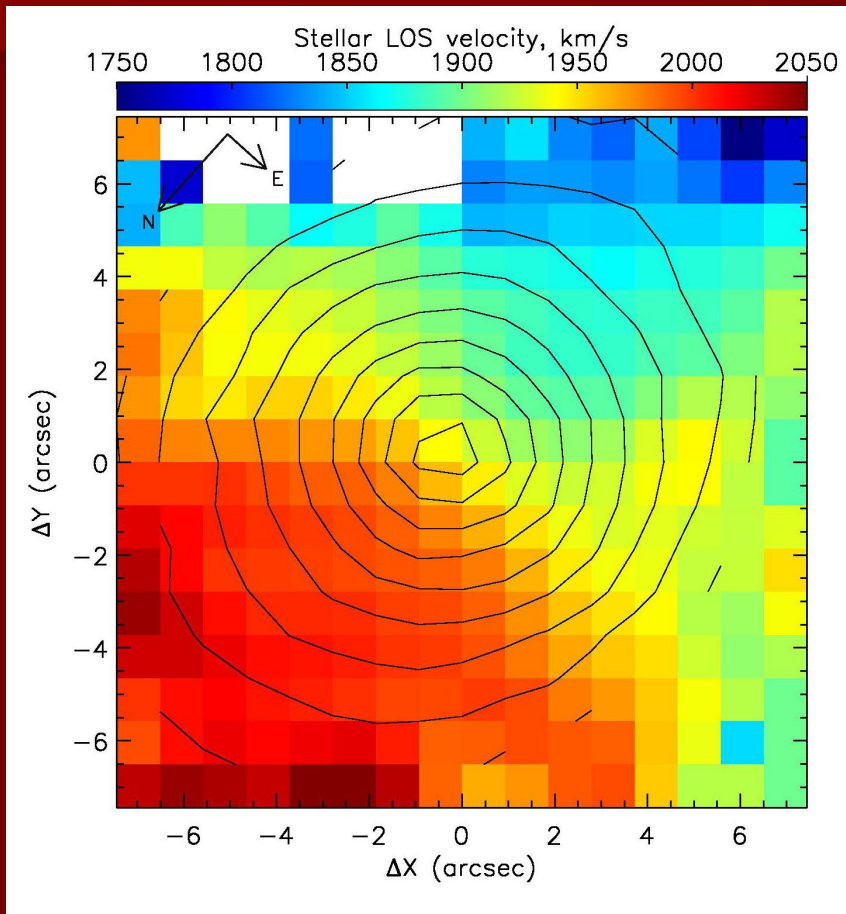
Hosts of  
the inner  
polar disks  
are  
ensquared



Nuclei

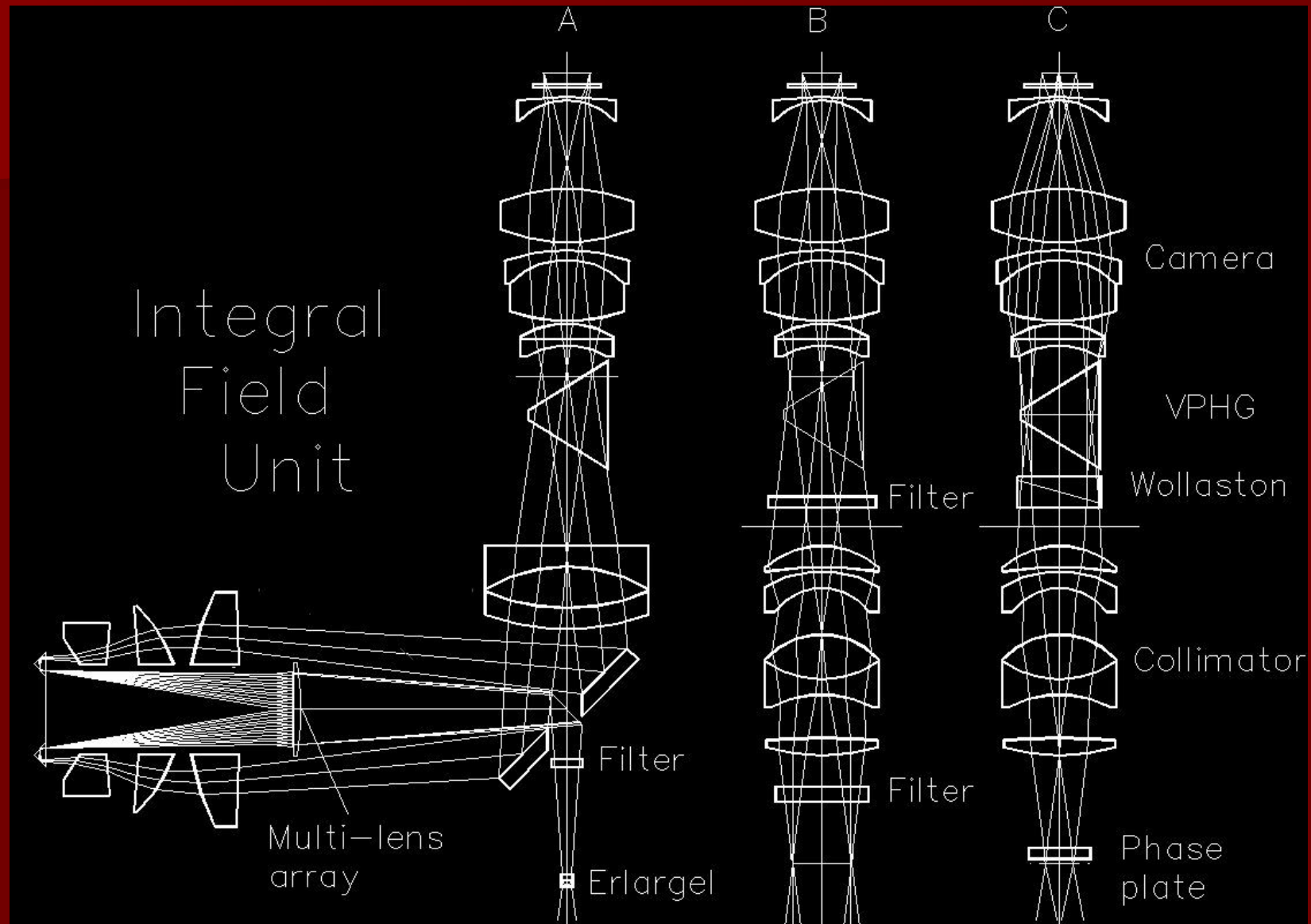
Bulges

# NGC 2962 with the MPFS/BTA



(unpublished yet, observed by Alexei Moiseev in 2007)

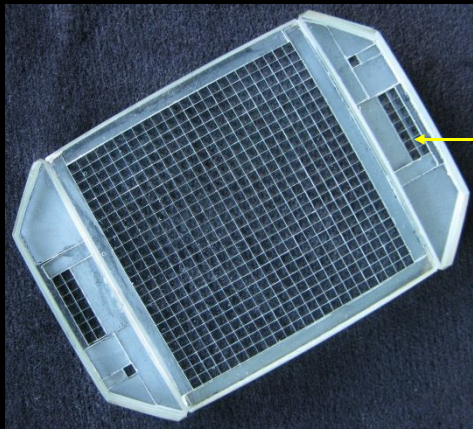
# Optical scheme of the SCORPIO-2



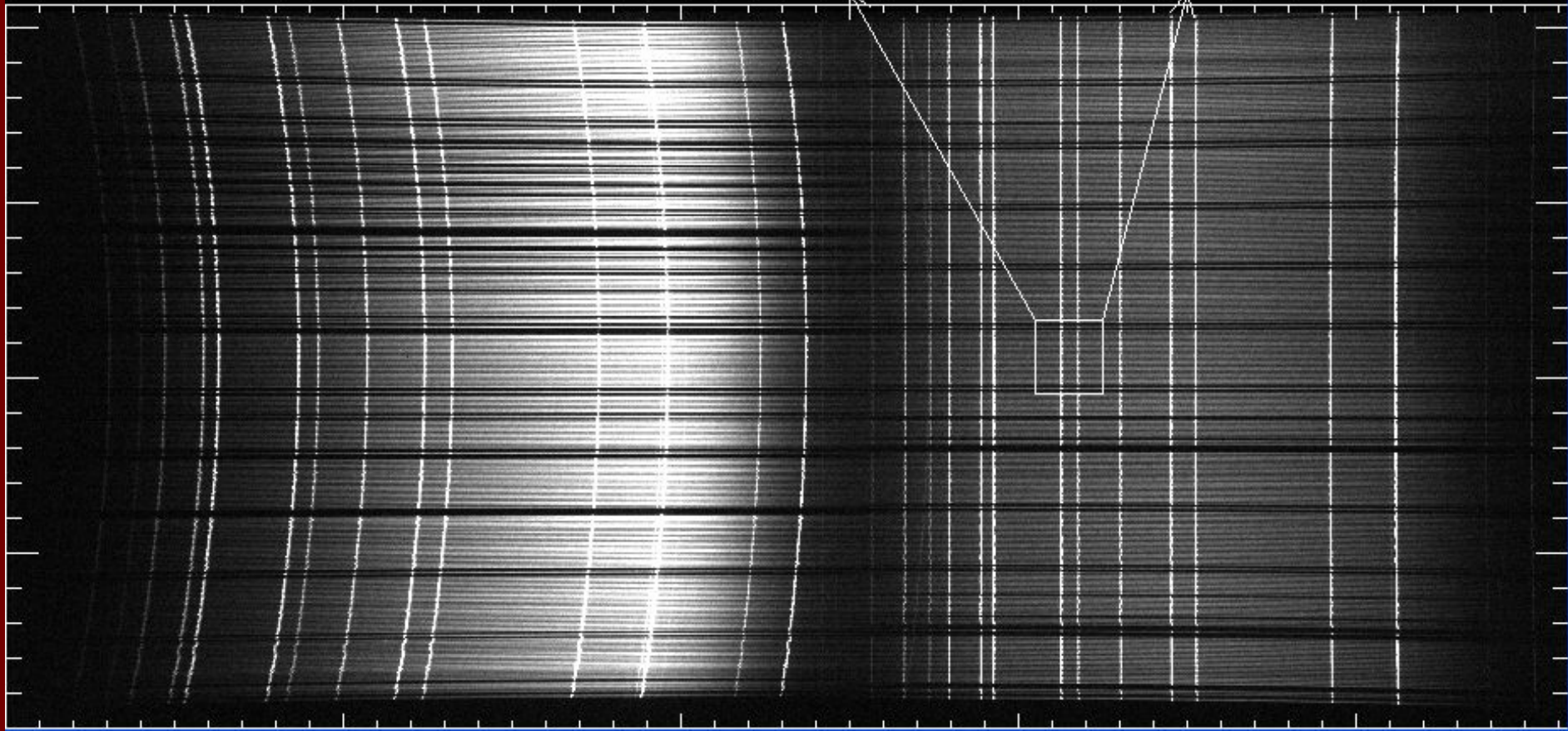
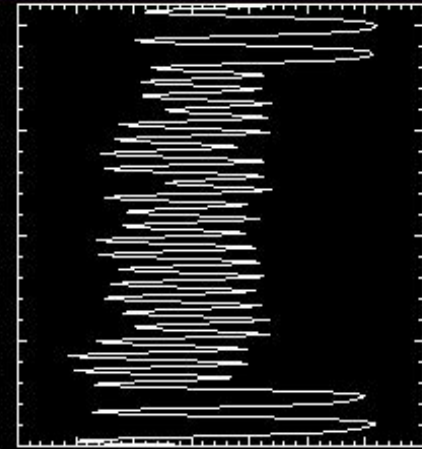
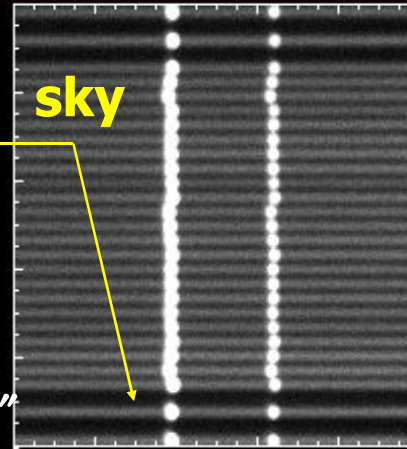
Courtesy by Prof. Victor Afanasiev



# 3D-spectroscopy in the IFU mode with SCORPIO-2



- two pseudo-slits, 302 spectra each,
- fibers attached to microlenses,  $\varnothing 150$  mkm
- field of view  $18'' \times 18''$
- spaxel size  $0.75'' \times 0.75''$



# Scanning Fabry-Perot interferometer at the 6m telescope BTA



SCORPIO

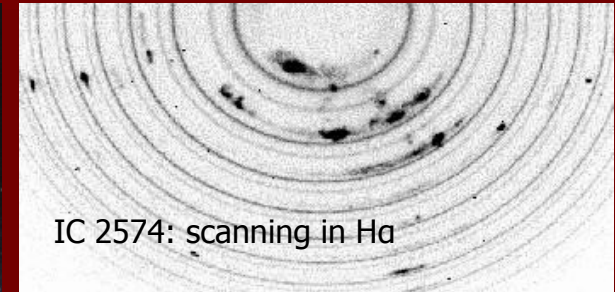


SCORPIO-2

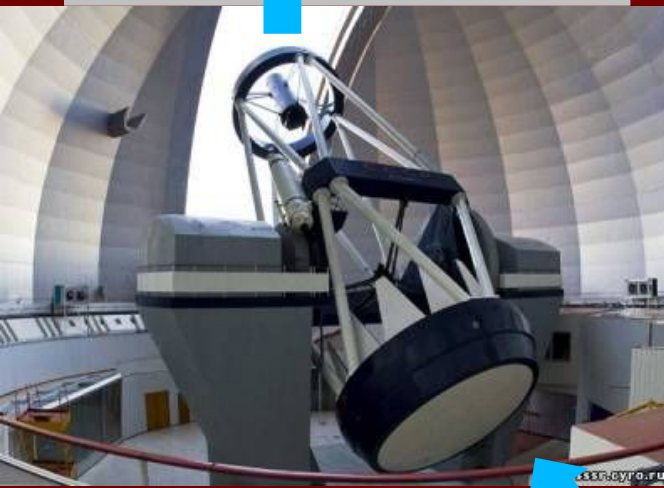
IC 2574 : image



Courtesy by Dr. Alexei Moiseev



IC 2574: scanning in H $\alpha$



FPI (now in SCORPIO-2):

Field of view: 6.1x6.1 arcmin

Spectral range: H $\alpha$ , [SII], [OIII] lines

Spatial sampling: 0.35-0.70 arcsec/px

Spectral resolution: R=4000-16000

*Afanasiev & Moiseev (2005, 2011)*

*Moiseev & Egorov (2008)*



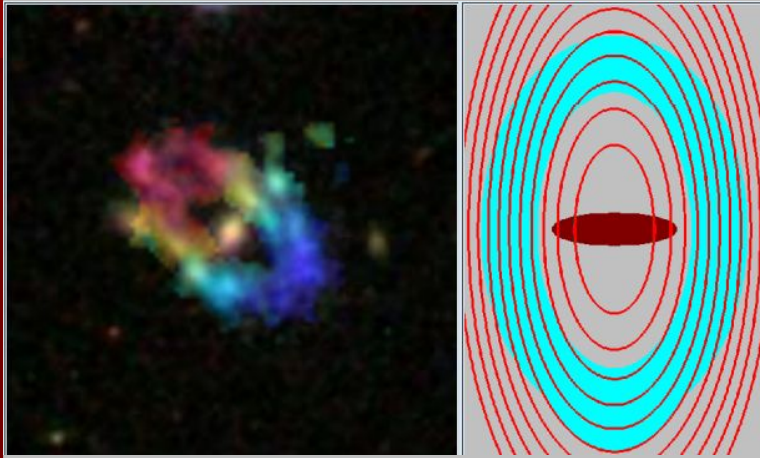
<http://www.sao.ru>



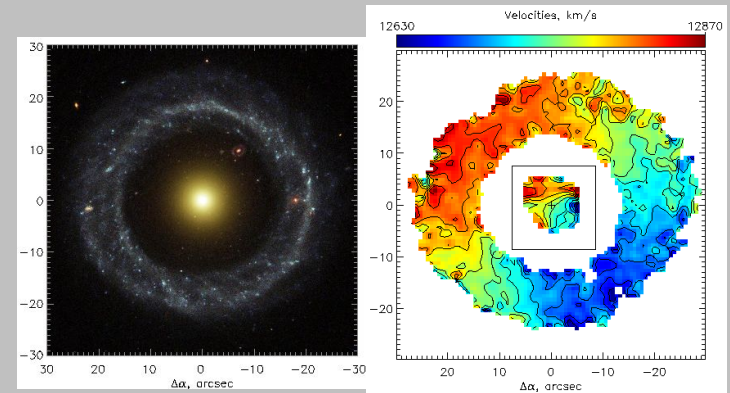


# Fabry-Perot mapping at the BTA: the recent results

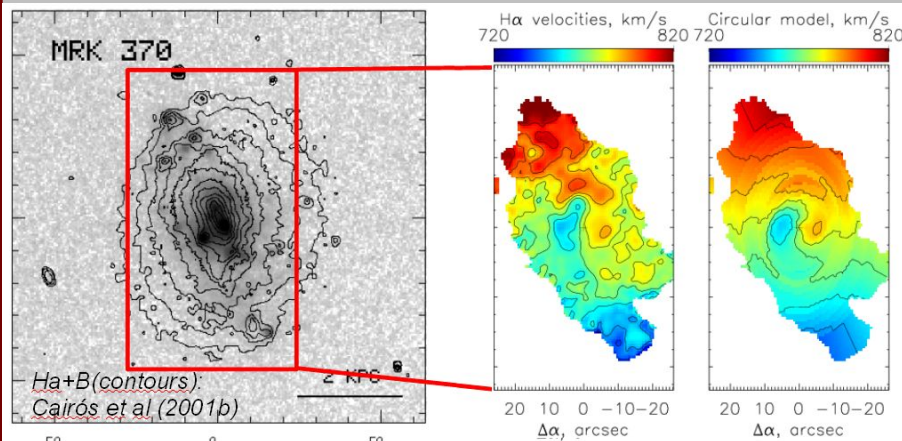
Dark halo shape in polar ring galaxies  
(Khoperskov et al, 2014)



Hoag object: evidence for cold gas accretion  
(Finkelman et al., 2011; Brosch et al. 2013)



Polar structures in dwarf galaxies  
(Moiseev 2011, 2014)



Wind-blown bubbles in dwarf galaxies  
(Egorov et al, 2014, in press;  
Moiseev & Lozinskaya 2012)

