

# The Structure of Polar Ring Galaxies

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## What Are Polar Ring Galaxies?

A polar ring galaxy (PRG) is a peculiar galaxy with two kinematically distinct components:

- 1) Gas-poor early-type central host galaxy (usually S0 or elliptical) surrounded by
- 2) Gas-rich late-type polar ring (lots of HI).

The two components have angular momentum vectors in nearly perpendicular planes. Polar rings come in a variety of shapes:

- 1) Annulus (NGC 4650A, UGC 7576)
- 2) Twisted morphologies such as double rings or a helix (NGC 2685)

## NGC 4650A



The ring is far more extended than the central host, and clearly bluer; younger stellar clusters are prominent in the outer parts

## Important Questions

The formation of PRGs is of great theoretical interest. The main questions are:

- 1) Why are nearly all the central hosts compact gas-poor galaxies?
- 2) Why are PRGs so rare (~0.5% of all S0 galaxies)?
- 3) Why do the polar rings have different shapes?
- 4) Why is the baryonic mass of the polar ring comparable to or sometimes greater than the host?
- 5) Why are the rings so inclined?
- 6) Why is the polar ring gas-rich while the central host is very gas-poor?

## Observations

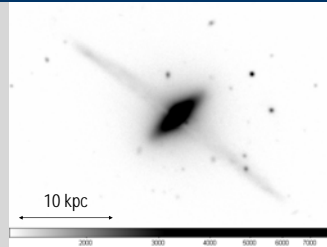
The table below is a log of images taken with the WIYN 3.5 meter telescope at KPNO with the Mini-Mosaic Imager.

Object	Date	Filter	Time (sec.)
UGC 7576	21 Feb 01	B	900
		R	600
NGC 2685 "Helix galaxy"	21 Feb 01	U	900
		B	600
NGC 3718	24 Apr 04	U	1200
		V	300
		R	240

## Reductions

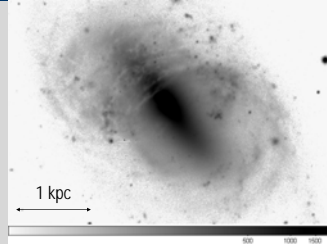
Standard image reductions are done in IRAF using the MSCRED package. Cosmic rays are removed using the IRAF task LACOSMIC developed by Pieter van Dokkum.

## UGC 7576 R



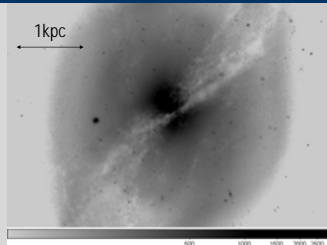
The ring is very thin (nearly planar) and it is not perpendicular to the apparent major axis of the host galaxy. This means either the ring is not round, the host is not axisymmetric, or the ring is not in a plane perpendicular to the host's equator.

## NGC 2685 B



The ring is quite messy and the material does not extend very far from the central host. The irregularities in the shape of the ring may reflect the age of the polar ring.

## NGC 3718 V

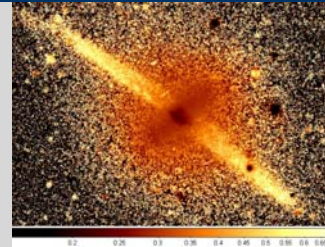


The ring has an obvious warp and is very extended like UGC 7576. Like the other two PRGs, dust lanes indicate the presence of dust in the ring. This suggests that the ring gas is not primeval material that fell-in; it has been part of a galaxy where stars made metals.

## Star Formation in the Polar Ring?

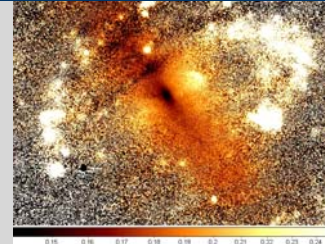
The color of PRGs can be examined by making a color map. The IRAF task GAUSS is used to match point spread functions in each image. The matched images are divided and displayed on a logarithmic scale.

## UGC 7576 B-R



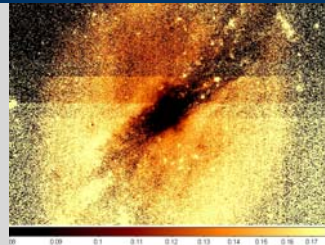
The two components are easily distinguishable by their color with the ring being bluer than the central host even though the ring is not very actively star-forming (little H $\alpha$ ).

## NGC 2685 U-B



The central host appears to be redder than its surroundings with bright white-blue knots of star formation scattered in the region of the ring.

## NGC 3718 U-V

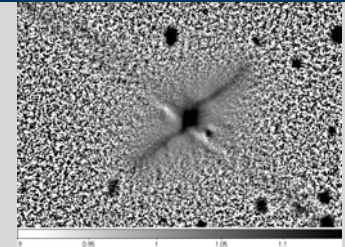


The ring does not appear appreciably bluer than the central host. However, the map reveals the presence of blue clumps, which may be compact star clusters with younger stars.

## Inner Structure of Central Host

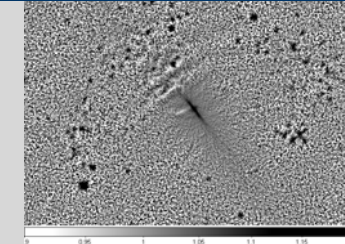
The small-scale structure of the central host can be emphasized by making residual image. A smoothed image is created by the IRAF task FMEDIAN. The original reduced image is divided by the median-filtered image.

## UGC 7576 R Residual



The central host contains an edge-on warped disk that is consistent with an S0 morphology.

## NGC 2685 U Residual



The central host contains an edge-on disk indicating an S0 morphology. The color map indicates that this disk is redder than its surroundings, which suggests the presence of dust in the disk.

## Acknowledgements

This work was supported by the National Science Foundation's REU program and the Department of Defense's ASSUE program through NSF Award AST-0453442.

## References

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