MORPHO-KINEMATIC CLUES TO THE ORIGIN OF SO BULGES

CALIFA Survey

Jairo Méndez Abreu

Cozumel, Mexico, 11.04.16
WHAT DO WE KNOW ABOUT S0 FORMATION?

- Major Merger Formation
- Inside-Out Formation

- High-Density Environment Evolution
- Gas-Stripping & SF Quenching
WHAT DO WE KNOW ABOUT S0 FORMATION?

- MAJOR MERGER FORMATION
  - INSIDE-OUT FORMATION

- HIGH-DENSITY ENVIRONMENT EVOLUTION
  - GAS-STRIPPING & SF QUENCHING

BULGES ARE KEY TO UNDERSTAND S0 GALAXIES
Classical Bulges

- Galaxy mergers Hopkins+10
- Dissipative collapse of gas clouds Eggen+62
- Coalescence of giant clumps Bournaud+07

Disk-like bulges (aka pseudobulges)

- Secular processes driven by bars Kormendy & Kennicutt 04; Athanassoula05
25 SO galaxies
Stellar masses \((10^{10} < M^*/M_\odot < 10^{11})\)
Red colors
Relatively isolated environment.
CALIFA PHOTOMETRIC DECOMPOSITION


- **Two-Dimensional**: GASP2D (Méndez-Abreu et al. 2008)
  - Sersic bulge
  - Type I, II, III disks
  - Ferrers bars
  - PSF Nuclear Sources

- **Multi-Component**: 

- **Phot. Decomposition**: SDSS bands: g, r, i

- **CALIFA DR3**: 400 gals. (exc. edge-on and interacting)
S0s STELLAR KINEMATICS

Quantifying the rotational support of bulges
SO bulges are fast rotators BUT most of them are NOT compatible with an isotropic oblate rotator model.
The photometric (n and B/T) and kinematic (λ) quantities of bulges are not correlated.
The photometric quantities of bulges are not correlated

Is this an inclination effect or is it intrinsic?
SO BULGES ANGULAR MOMENTUM
PHOTOMETRY vs. KINEMATICS
SO BULGES ANGULAR MOMENTUM
PHOTOMETRY vs. KINEMATICS
The lack of correlation is independent of the viewing angle and it is intrinsic to the bulges.
Our galaxy sample is representative of S0s with
- High stellar masses \((10^{10} < M_{\star}/M_\odot < 10^{11})\).
- Red sequence
- Field and loose groups.

Our S0 bulges are fast rotators

Anisotropy is needed to maintain their structure

The photometric \((n \text{ and } B/T)\) and kinematic \((\lambda)\) properties of the S0 bulges are not related.

The bulge (photometry and kinematic) and galaxy (masses and environment) suggest that our S0 bulges were mainly formed through dissipational major mergers at high redshift. Then, galaxies evolved secularly through both external accretion of satellite galaxies (inducing changes in the bulge properties) and internal bar-induced mechanisms in gas-devoided disks (with no creation of central structures).
S0s ANGULAR MOMENTUM - BULGEs vs. DISKS

S0 disks lie along the isotropy line and with larger angular momentum than bulges.
Ellipticals have lower angular momentum than bulges and some of them are slow rotators.
PHOTOMETRIC DEFINITION OF BULGE