Subaru Uncovers the Hidden Secret of NGC 1068

(Tanaka et al. 2017, PASJ vol. 69, p90)

Subaru Telescope, NAOJ

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with

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Abstract

- **NGC1068** is one of the closest Type-2 Seyfert, and is the **“touchstone”** for the AGN theories.
- **Minor-merger with a Nucleated (=w SMBH) Satellite Galaxy should trigger the AGN activity on NGC1068 (Taniguchi 1999)? A test would be to detect the signature of the event.**
- **Deep imaging for NGC1068 for the first time** → We discovered **quite rich structures** around the galaxy! This is consistent with the minor-merger triggering hypothesis.
- Our result opens the new method for the morphology analysis for Seyferts.

「すばる」への道/Subaru Facebook

NGC 1068 as a touchstone for AGN Ignition Theories

NGC1068 … One of the Nearest Seyfert Galaxies. Very famous.

Plenty of the Detailed Observations → “Touchstone” for AGN models.

A Challenge on AGN Triggering model:
How we can effectively dump the gas on the SMBH from over 1kpc to $<10^{-2}$ pc?

Intenal Origin (Bar Instability)

vs.

External Origin (Interaction/merger)

The AGN Unification Model

- Taniguchi (1999, ApJ, 524, 65)

Minor Merger with the “Nucleated (=SMBH)” satellite can be the major mechanism for Seyfert galaxies.

SKYLIGHT

誰が銀河中心核に火をつけたのか？
—スターバースト・活動銀河中心核の
進化的統一モデルへの道—

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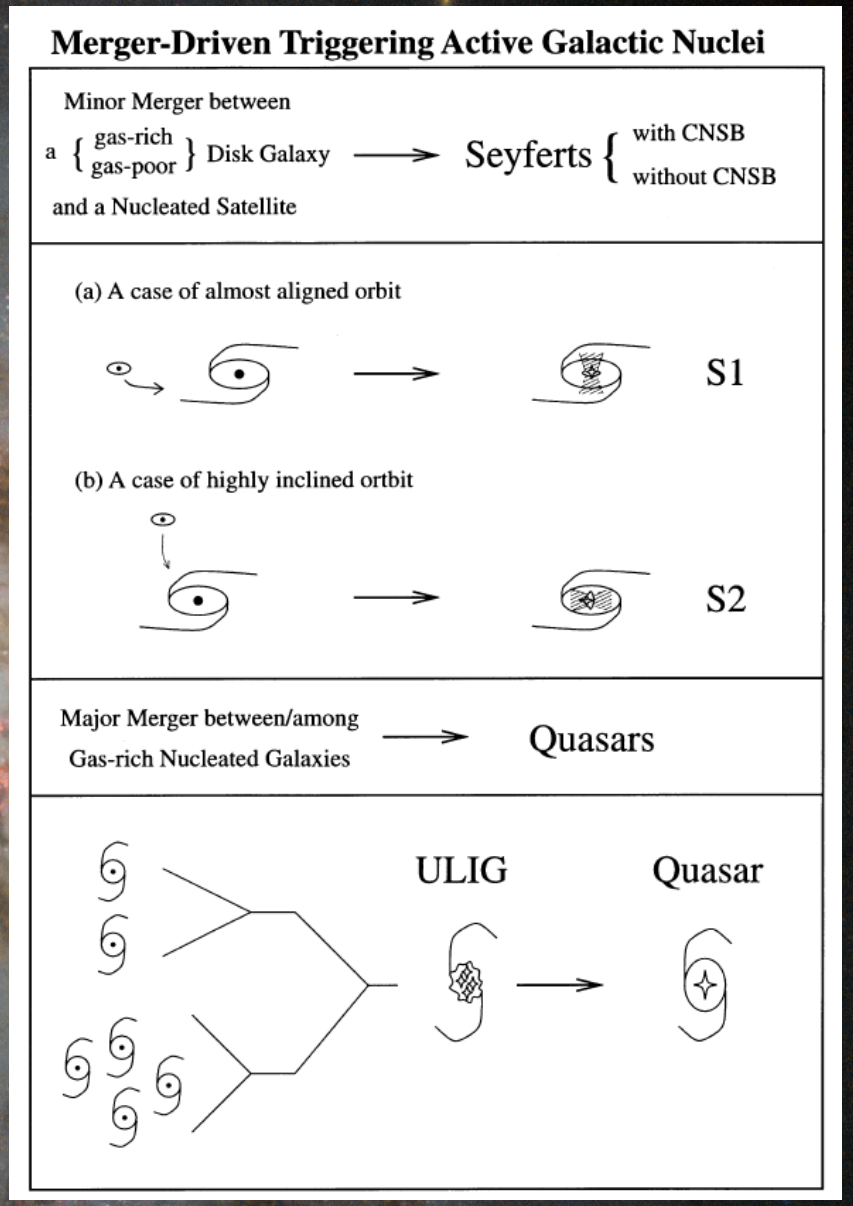
銀河中心領域で観測される活動性は2種類ある．活動銀河中心核（active galactic nuclei; AGN）とスターバーストである．なぜ，2種類の活動性が起こるのか？　また，それぞれどのようなメカニズムで発生するのか？　両者には何か物理的なリンクはあるのか？　これらの疑問を解明するために，多くの研究がなされてきた．本稿では歴史的経緯を含めて，AGNとスターバーストのレビューを行い，そのあとで銀河の合体に基づくスターバーストからAGNへ至る進化的な統一モデルを解説する．

1.　ミッション・インポッシブル　　2.　特別な場所

天文月報 2016年5月号



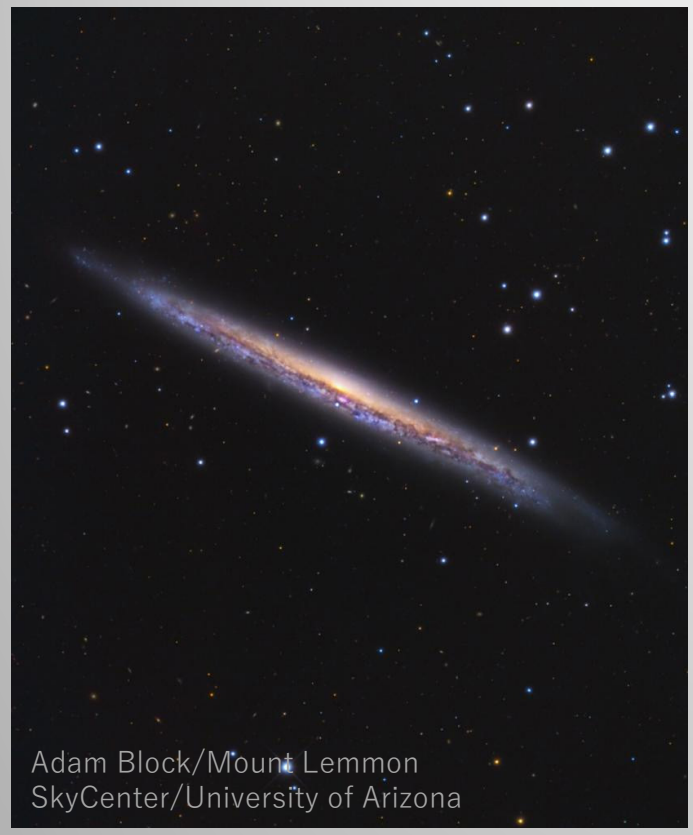
Taniguchi (1999)

However, proving this is not an easy task…because the **sign of the past minor merger is easily smeared away.**

NGC1068 “A Conventional View”

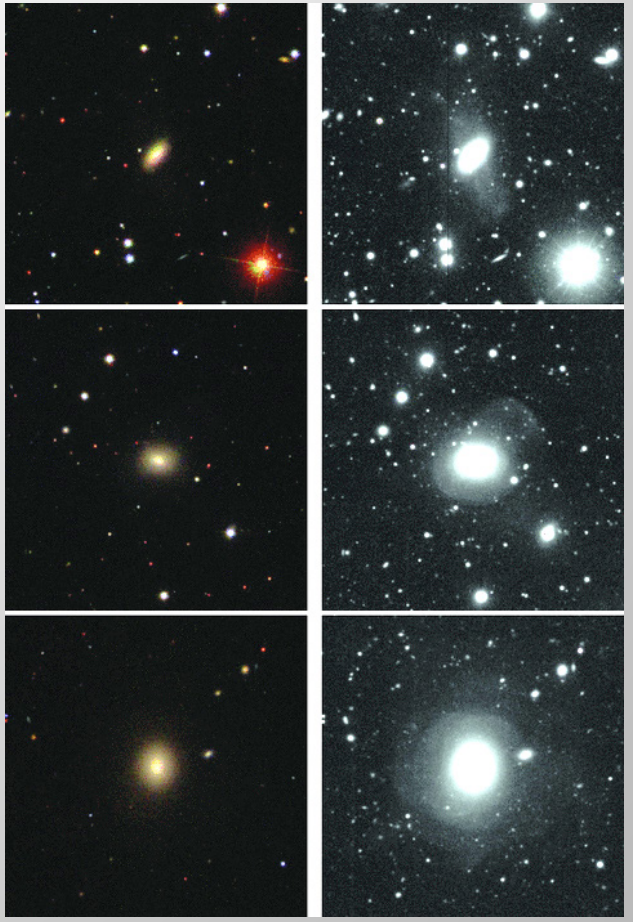
Apparently NO SIGN of dynamical disturbance
→ Often considered as the example of the Secular Evolution Trigger.

However…



NGC5907

Martínez-Delgado et al. 2008

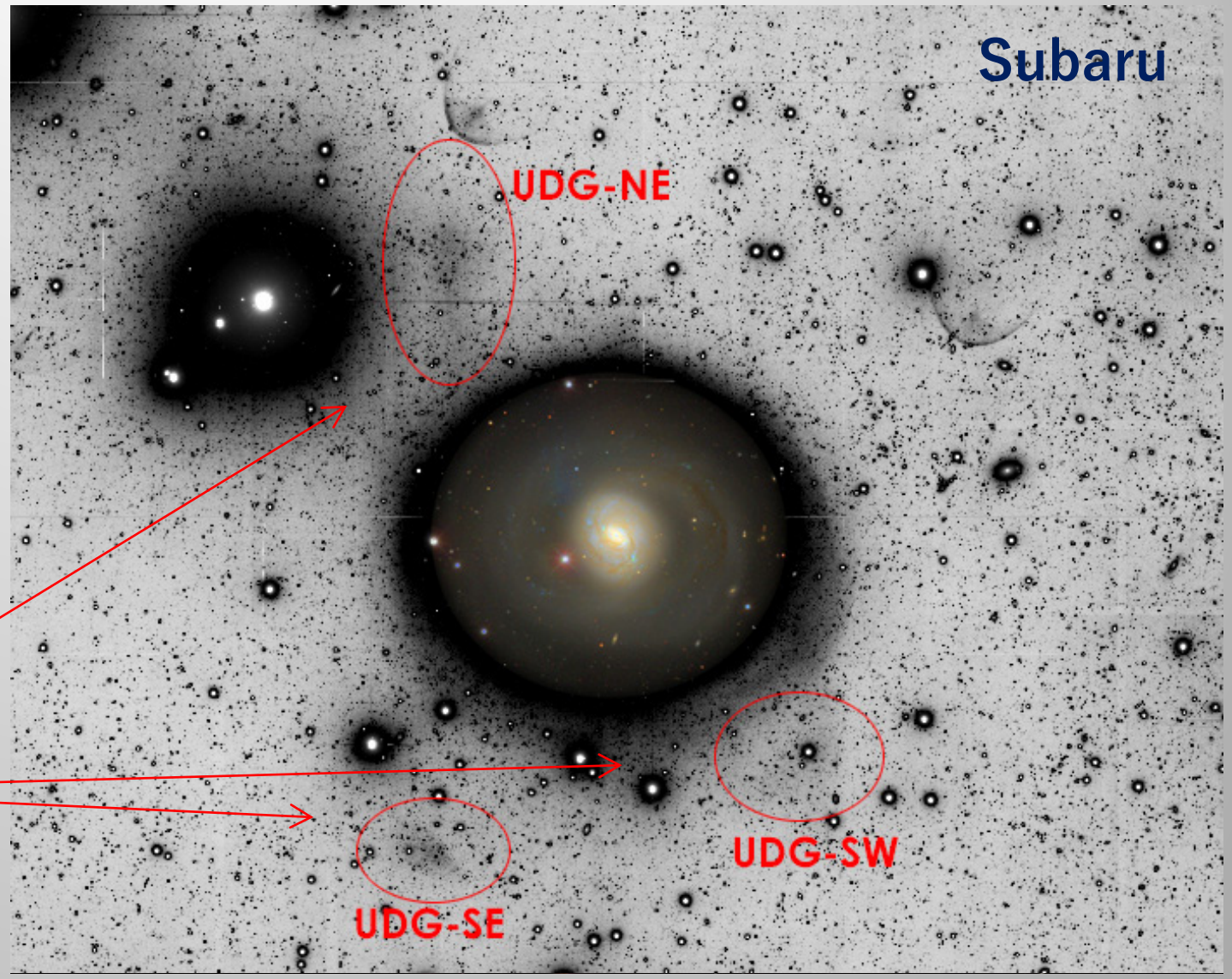


Kavilaj et al.(2010)

Recent Searches for Extremely Faint Structures actually detect the past minor merger events happened ~Gyrs ago…

… then why not for NGC1068?

- It's a Gamble: any available images of NGC 1068 show no hint of dynamical events…
- The Start of the "HSC Filler Program" : It's a GREAT Chance!
- After a year's waiting, we finally got the data in 2017.



RESULT:

"What are they!?"

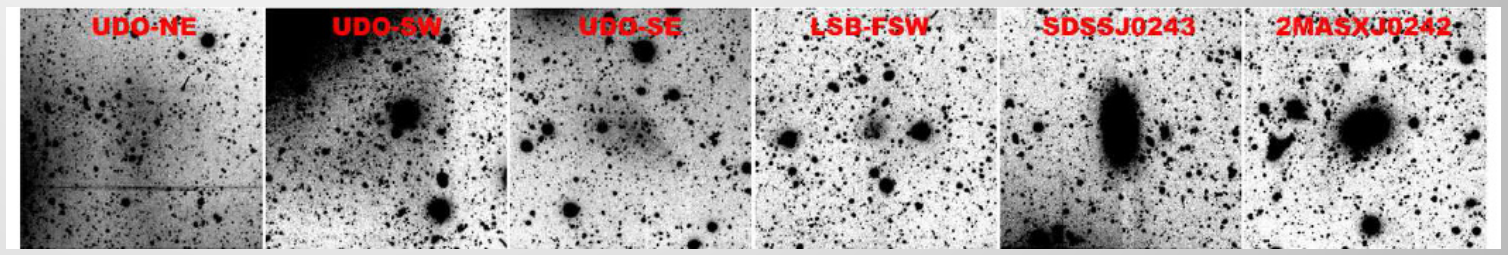
S.B.> 26mag/arcsec^2 & huge size (>1.5kpc)

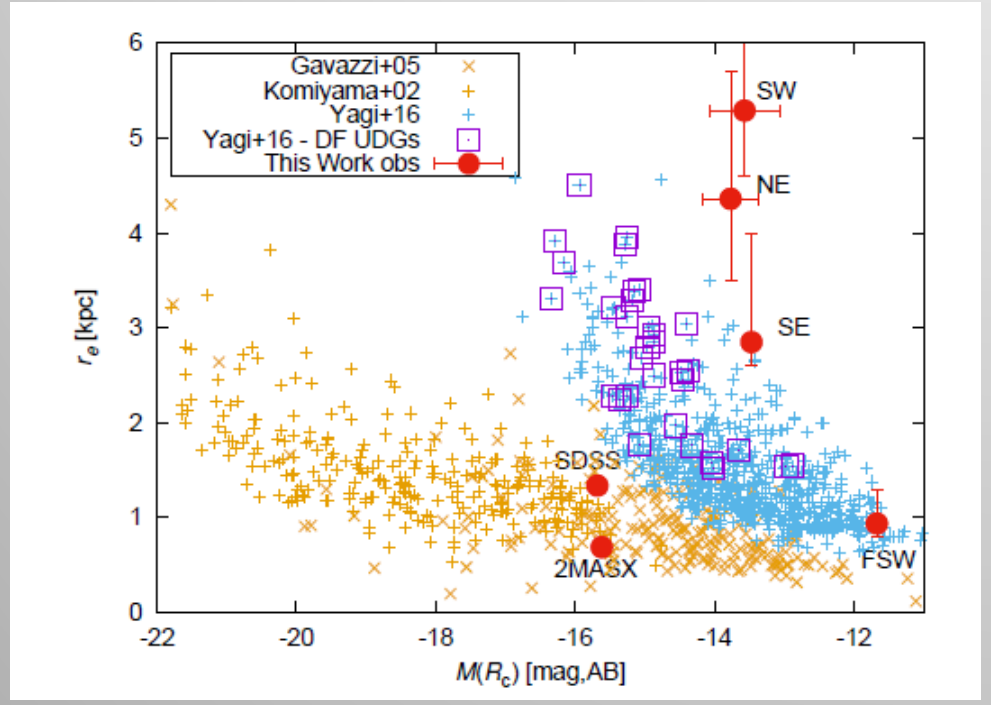
(r band, Exposure=46min, Seeing~1.0 arcsec)

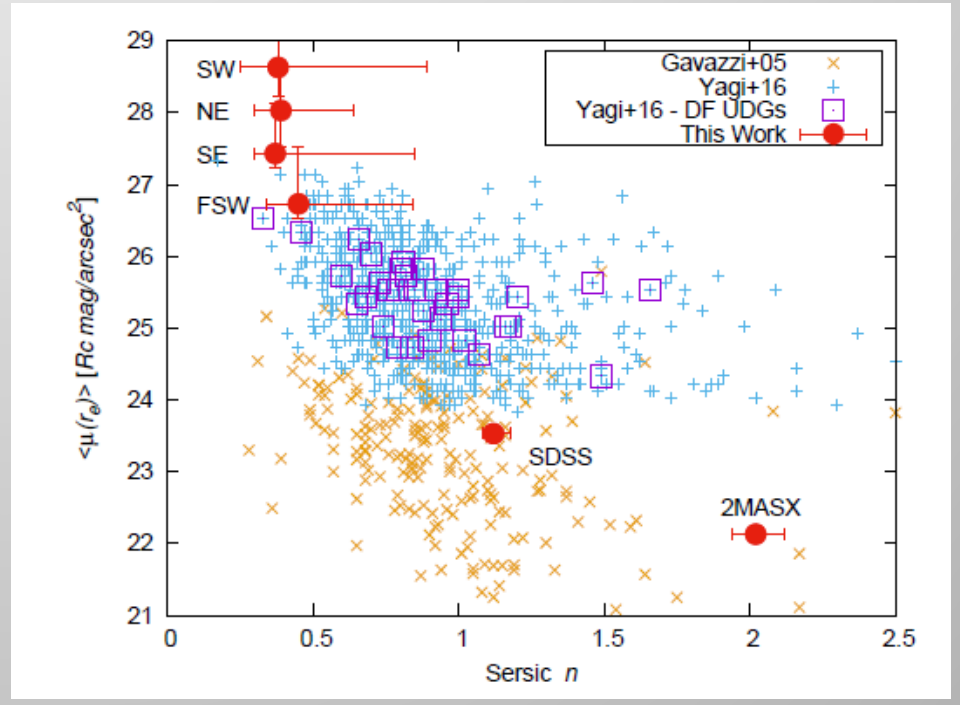
Structural Parameters of the ‘UDOs’

- Sersic n < 1.
- Extremely large r_e.
- Extremely low SB.

[dist=15.9 Mpc; 1kpc=13”]

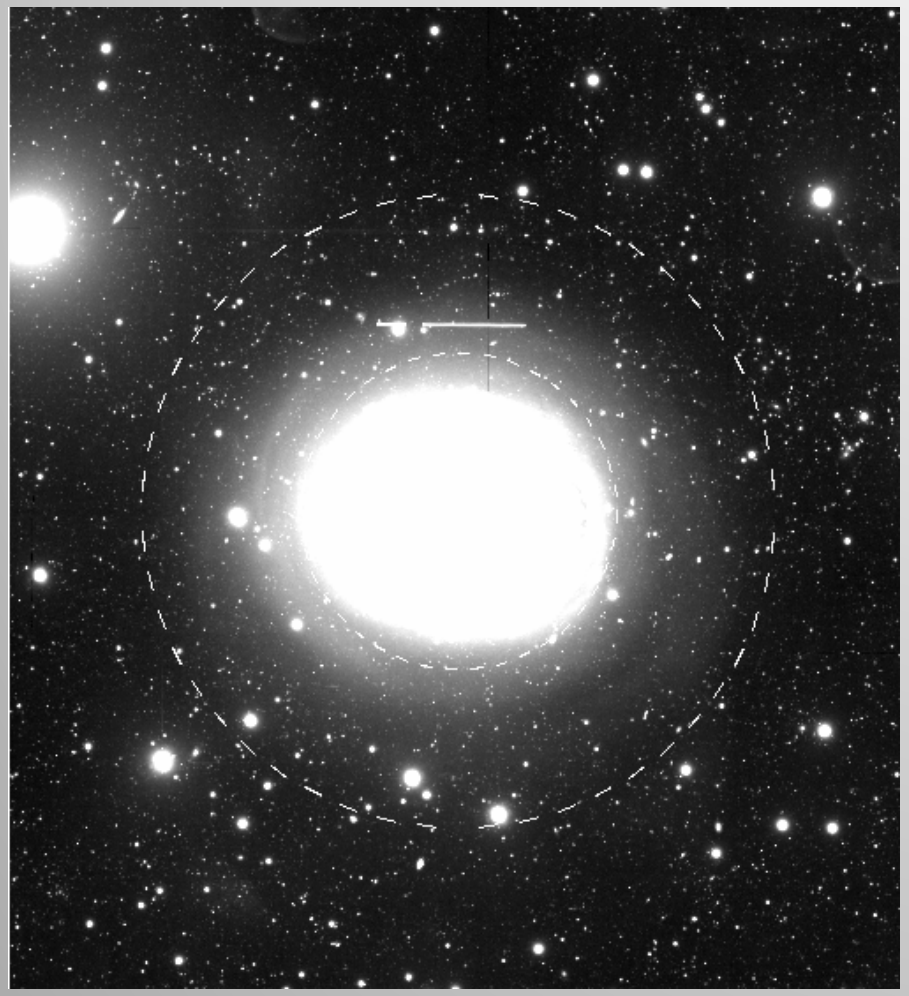


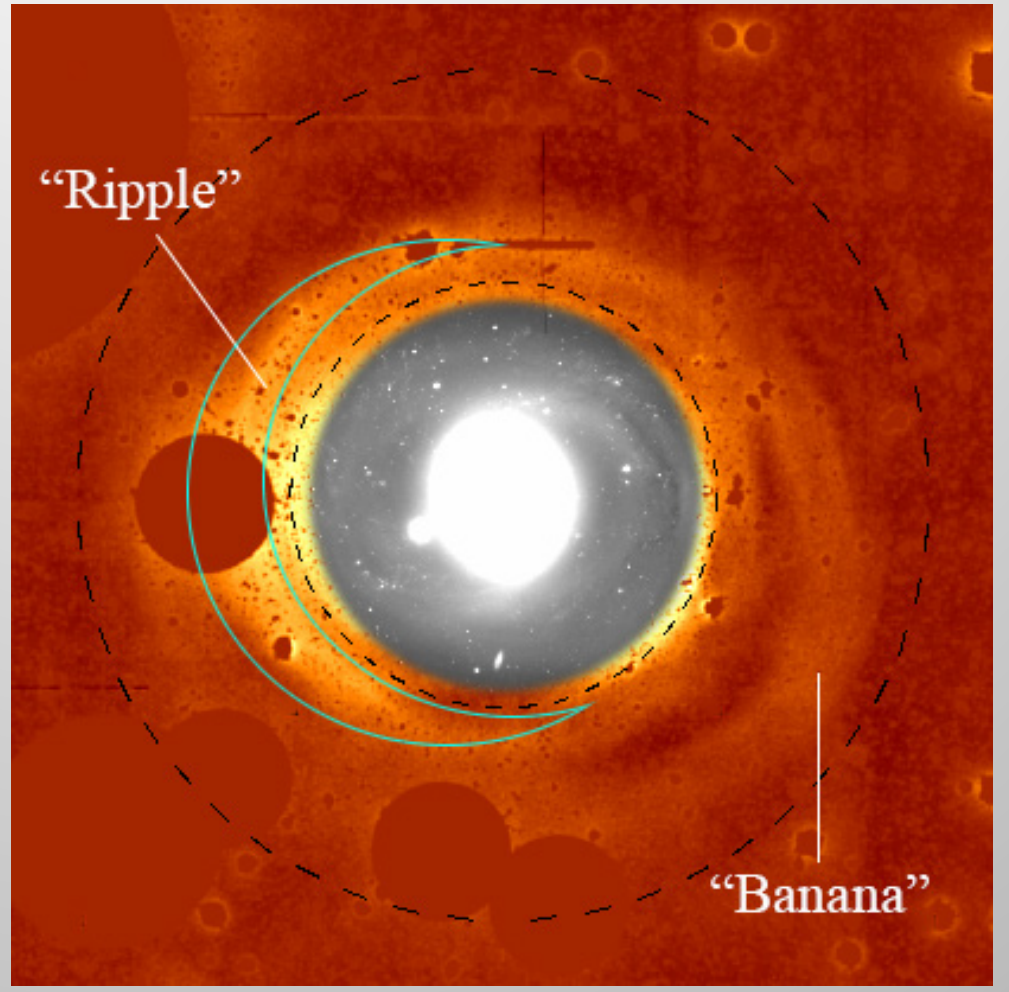


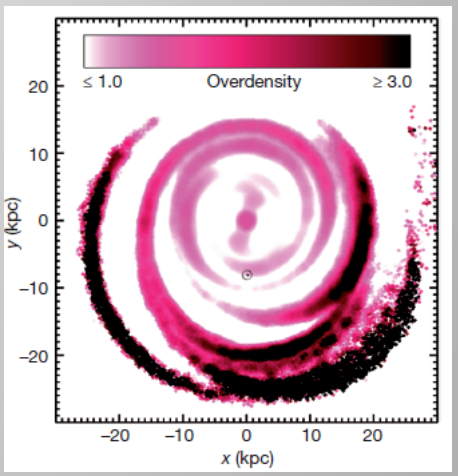


Unusual Structures on Outer Disk Revealed!

Contrast Enhancement Technique → Extremely-faint Outer Structures



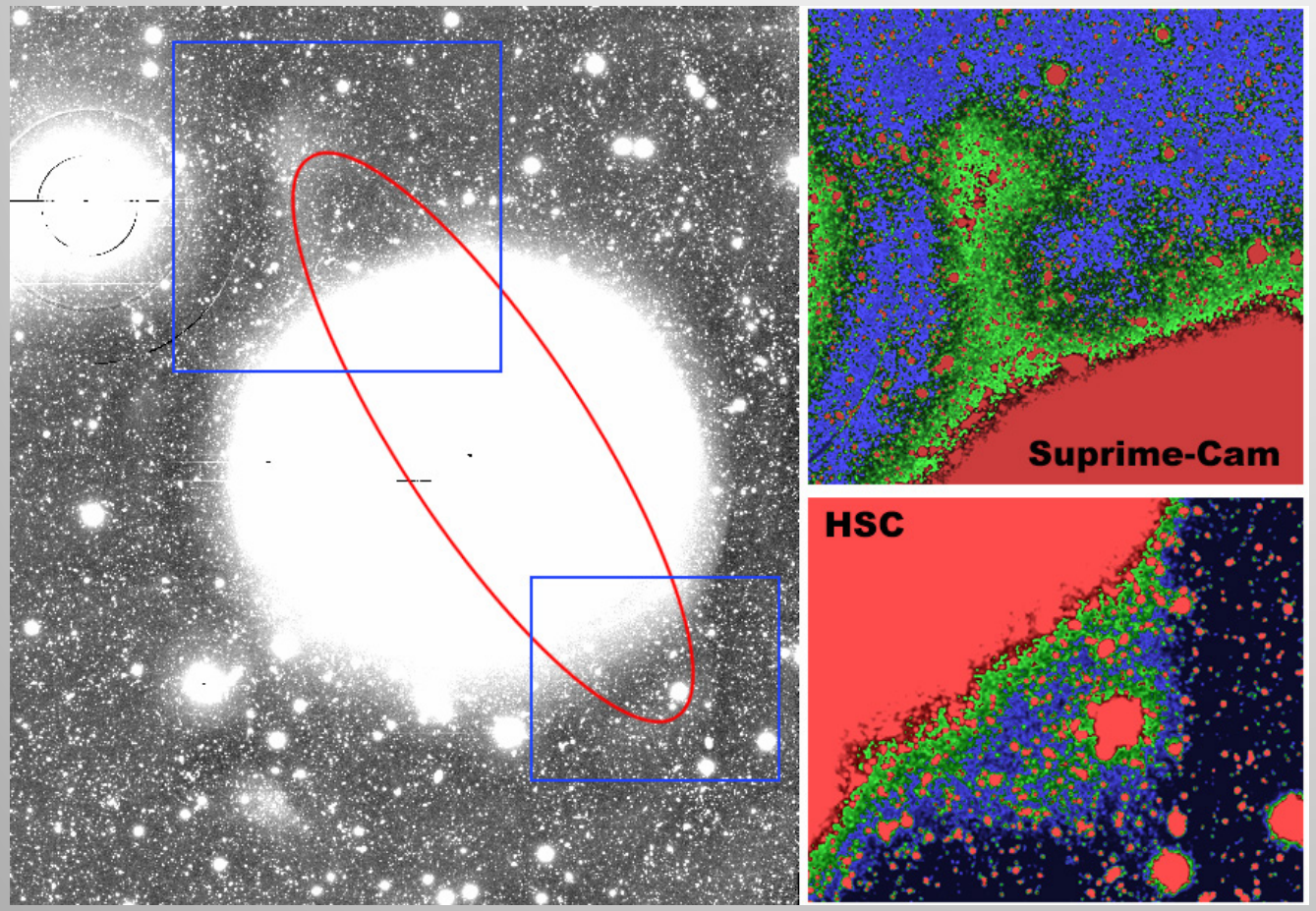




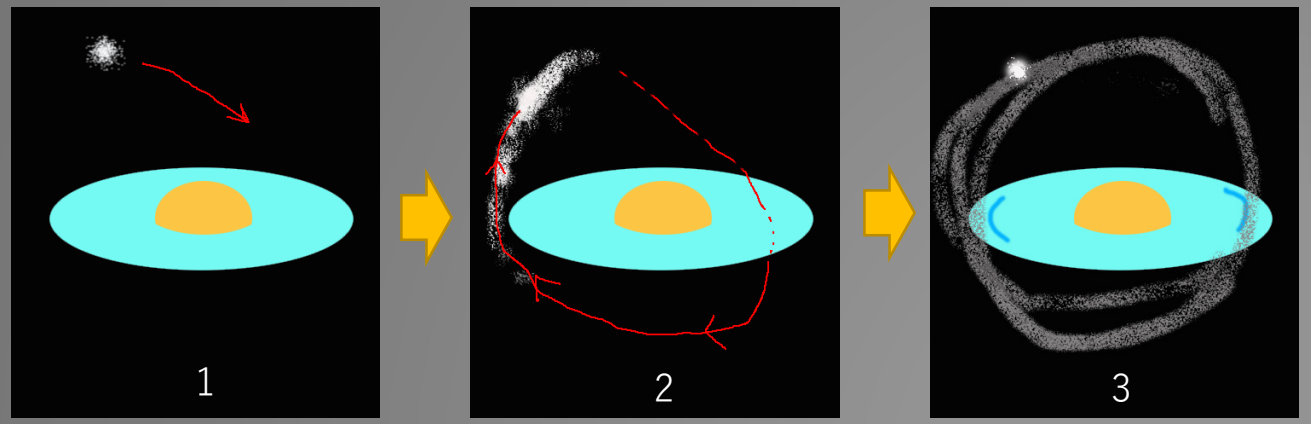
Ripple formation via minor mergers: Purcell et al. (2011, Nature)

Ultra Diffuse Objects → Tidal Stream

Contrast Enhancement → Hint of Stream structures revealed.
Likely the remnant of the past minor merger ~ a few Gyrs ago.



A Possible Scenario…



(1) Several Gyrs ago, the Infall of a nucleated satellite galaxy has happened.

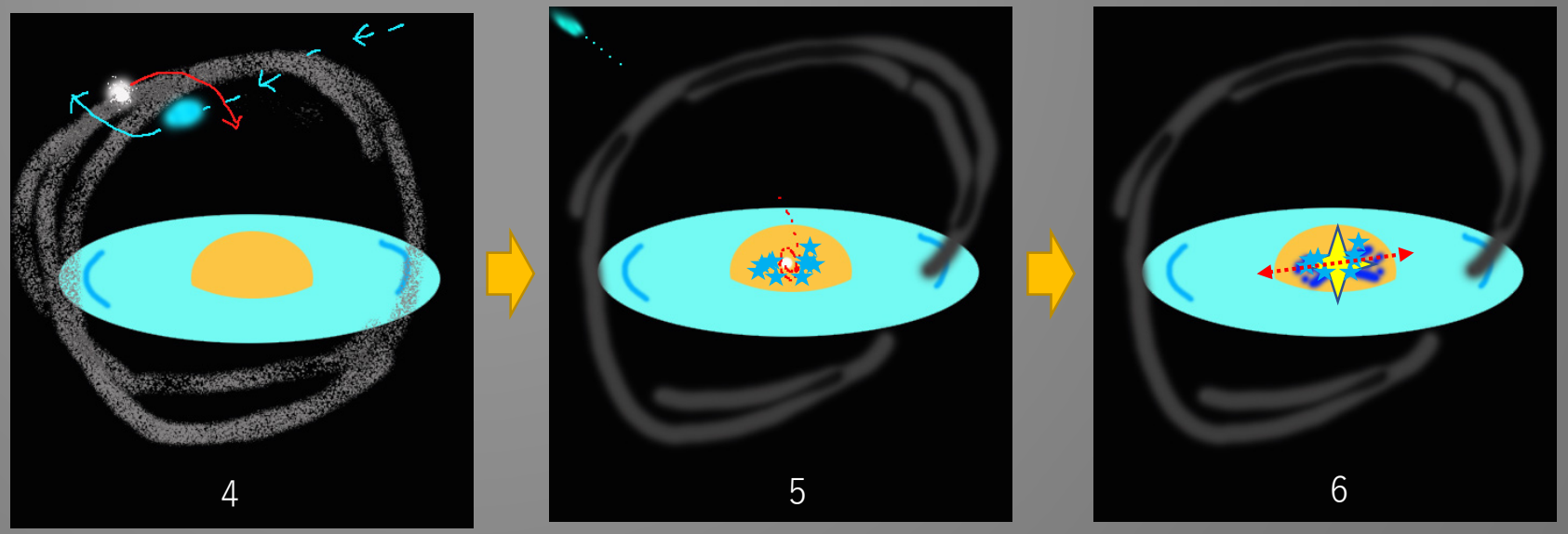
(2) It interacts with the disk, then…

(3) The “roop” is eventually created, while the ripple-like structure is generated on the disk.

(4) At this point, another dwarf galaxy has passed near the nucleus, changing its orbit towards the center of NGC1068.

(5) The core of satellite galaxy stimulates the star-formation near the galaxy center.

(6) Then finally the SMBH of satellite reaches the nucleus of the main SMBH, creating the dust torus while it triggers the AGN activity (present view).



Conclusion

- Under the standpoint of the minor-merger-driven AGN triggering mechanism proposed by Taniguchi (1999), we have seeked for the any sign of the past minor merger for NGC 1068 using the Subaru HSC.
- We have discovered three very large and extremely faint objects around NGC 1068. The morphology of these faint structures suggests that they actually constitute a ring-like structure on the main disk of NGC 1068, similar to the 'loop' structure we see on the NGC 5907.
- We also found that there are two ripple-like structures on the faint outer disk of the galaxy. Such morphologically unusual signatures are shown to be made by minor-merger events via simulations by Percell et al.(2011).
- Our discovery on NGC 1068 supports the idea that the minor merger is the dominant mechanism for the triggering of Seyfert galaxies.
- We got the new HST time for a systematic study to look for the faint signature of the Seyfert galaxies(Yagi et al. S18A014QN)!

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→ ENGLISH

Subaru Web Release:
“Minor Merger Kicks Supermassive Black Hole into High Gear”
「衛星銀河の合体が超巨大ブラックホールに活を入れる」

Message to You:
“New Collaboration Will Kick YOU into High Gear”

ブラックホールに活を

重力波天体が放つ光を初観測

衛星銀河の合体が超巨大ブラックホールに活を入れる

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おすすめコンテンツ


Thank you!