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Composite Bulges – V. Detecting signatures of gas inflows in IFU data: The MUSE view of ionised gas kinematics in nearby galaxies

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цели

- Gas inflows in galaxies can significantly affect their evolution by enhancing nuclear star formation
- One of the most established mechanisms causing gas inflows involves shocks driven by bars.

Our objective in this work is to study the ionised gas kinematic maps of galaxies in search of the signatures of extended shocks

Данные

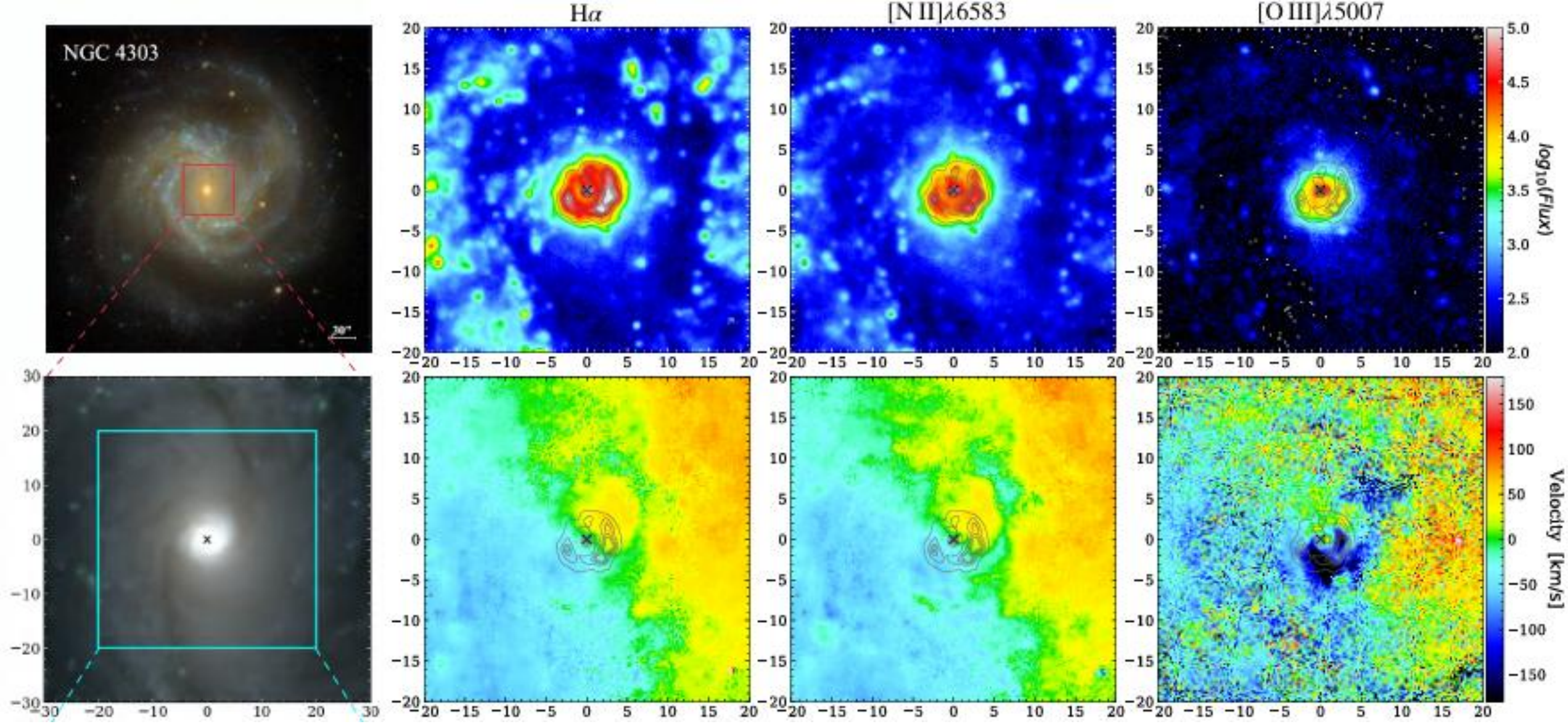
- MUSE VLT из разных программ, основная часть снята специально для Composite Bulges Survey, CBS (The CBS sample is a mass- ($M* \geqslant 10^{10} M\odot$) and volume (distances $\leqslant$ 20Mpc) limited set of 53 S0–Sbc galaxies with Galactic latitude |b| >20◦, and inclinations between 35◦and 60◦)
- The sample has optical and NIR imaging from the Hubble Space Telescope, allowing us to resolve details as fine as ∼15pc.

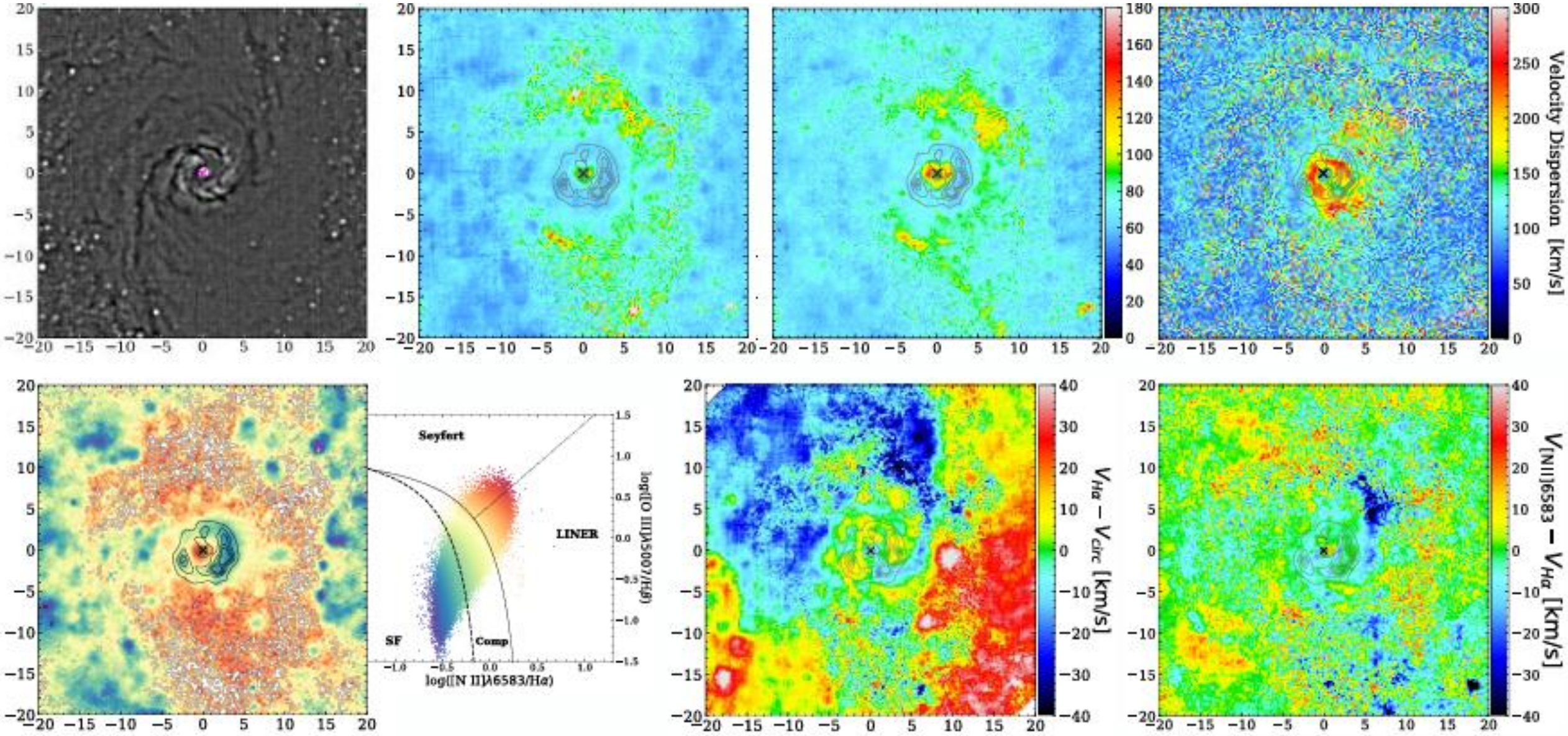
↓

21 галактика с заметными эмиссионными линиями в более чем 50% спакселей

Методы

- DAP (employs the commonly used penalised pixel-fitting (PPXF) code to perform both stellar and emission line analysis. It can also perform stellar population analysis)
- Stellar kinematics in the form of line-of-sight velocity distribution moments (LOSVD) – mean velocity (V), velocity dispersion(σ), and higher order Gauss-Hermite moments (h3 and h4)
- EMILES single stellar populations
- Отдельно работали с многокомпонентными спакселями (в 3 галактиках, в [OIII] вторых компонент нет, только Ha)


NGC 4303
Hα
[N II]λ6583
[O III]λ5007
log10(Flux)
Velocity [km/s]


Velocity Dispersion [km/s]
Seyfert
LINER
SF
Comp
log([O III]λ5007/Hβ)
log([N II]λ6583/Hα)
$V_{H\alpha} - V_{circ}$ [km/s]
$V_{[NII]6583} - V_{H\alpha}$ [km/s]

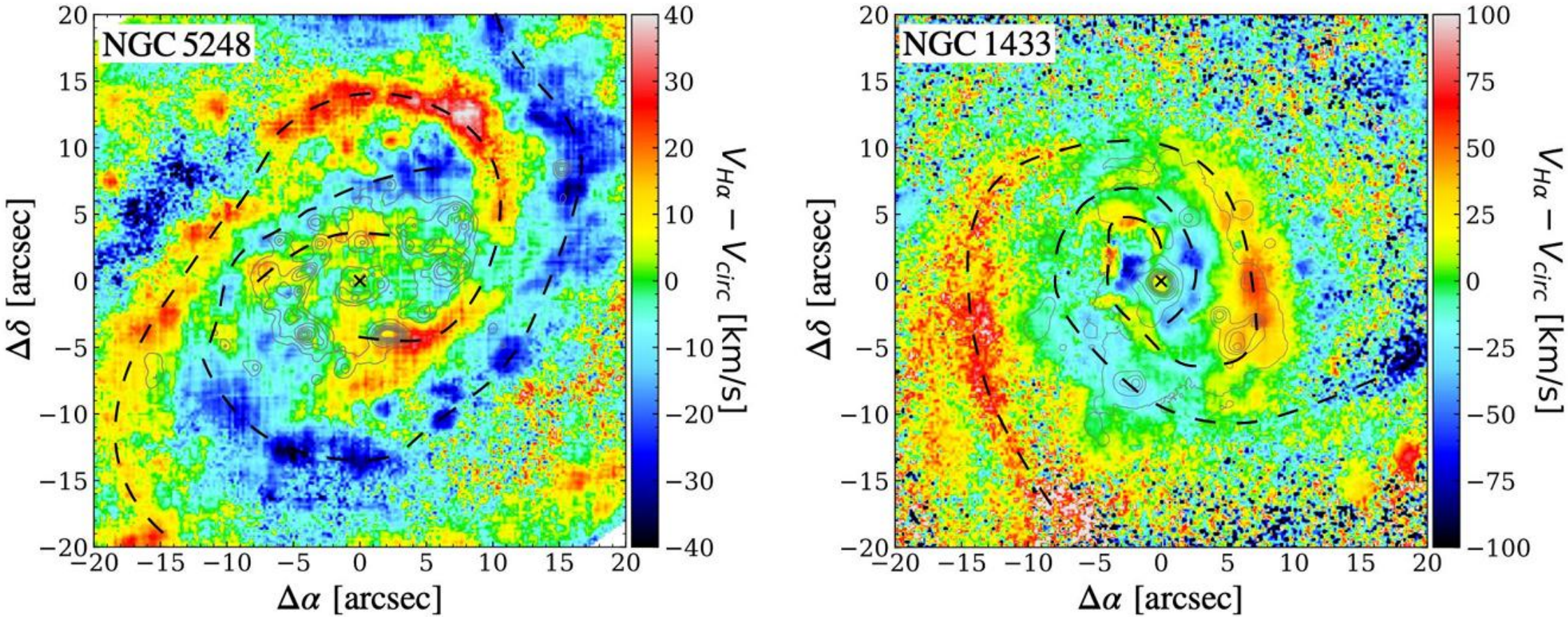
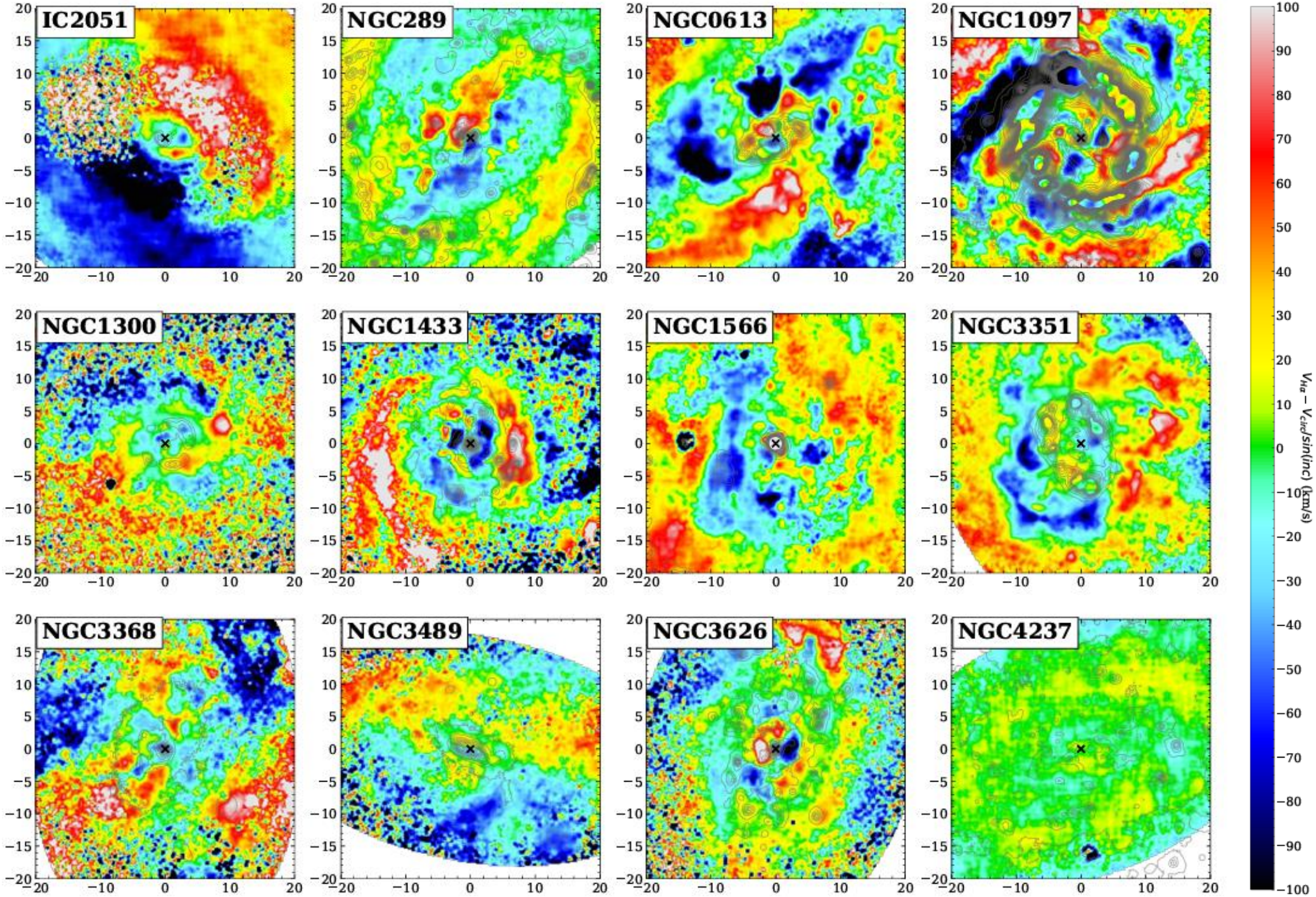
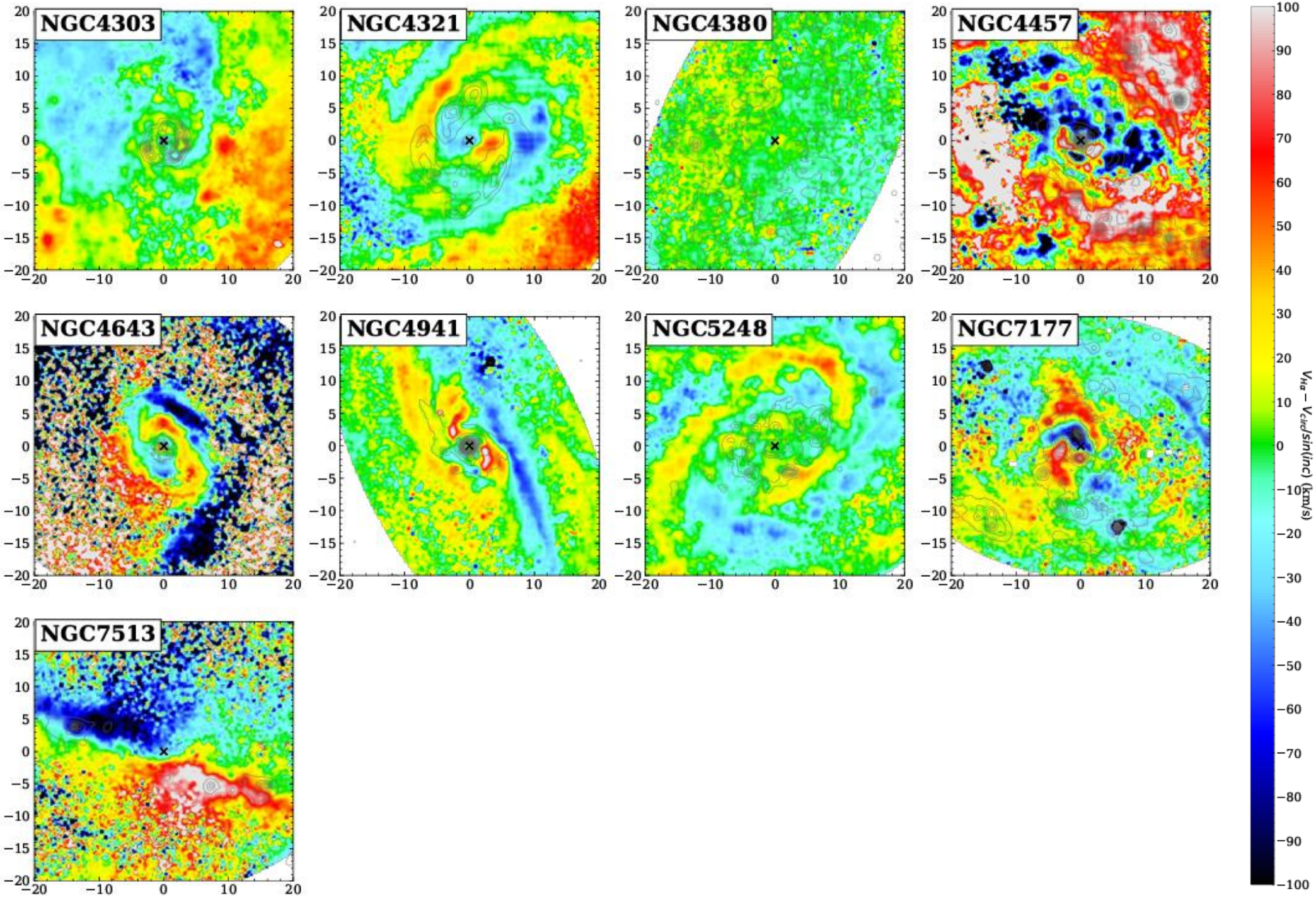


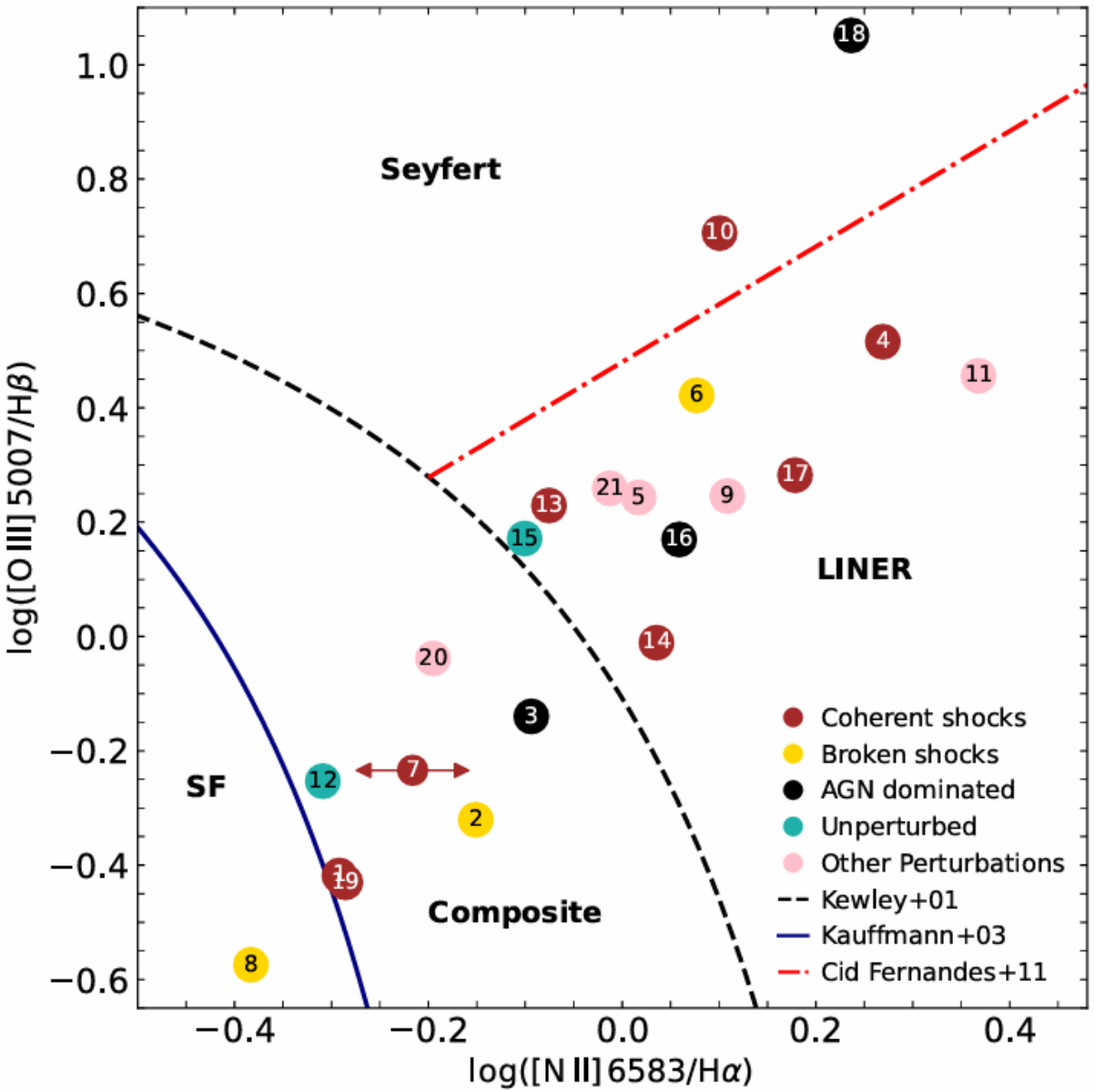
Figure 3. Residual velocity map of NGC 5248 (left) and NGC 1433 (right). The centre of the galaxies are marked with an "x". The black dashed lines mark the approximate locations of signatures of extended shocks. The signatures seen in NGC 5248 are classified as "coherent shocks" and in NGC 1433 as "broken shocks" (see Sect. 5.3).


IC2051
NGC289
NGC0613
NGC1097
NGC1300
NGC1433
NGC1566
NGC3351
NGC3368
NGC3489
NGC3626
NGC4237
$V_{H\alpha} - V_{circ}/sin(inc)$ (km/s)


NGC4303
NGC4321
NGC4380
NGC4457
NGC4643
NGC4941
NGC5248
NGC7177
NGC7513
$V_{obs} - V_{circ}/sin(inc)$ (km/s)

Выделили 5 кинематических категорий

- **Coherent shocks** (compelling, extended shock signatures that span coherently – either straight or spiralling inward – over large distances into the inner parsecs regions)
- **Broken shocks** (these structures appear rather discontinuous, possibly due to strong local activities disrupting the propagation of the shocks)
- **Other perturbations** (includes galaxies that do not exhibit compelling signatures of extended shocks associated with inflow. However, the kinematic fields of these galaxies are strongly perturbed)
- **AGN-dominated** (in the innermost regions the kinematics are obscured by strong outflows from AGNs)
- **Unperturbed**



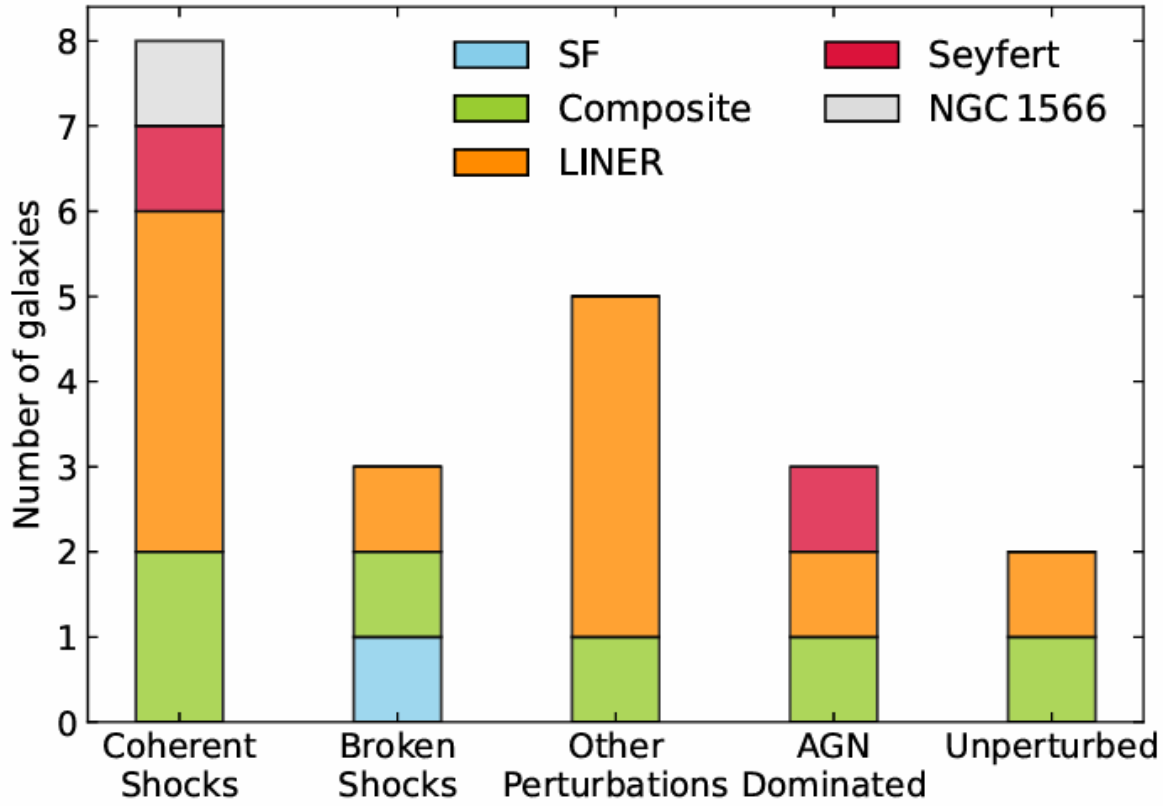


Figure 5. The distribution of galaxies stacked in each kinematic category, colour-coded based on their nuclear emission types, both classifications are defined in Sects. 5.3 and 5.4. Different colours represent SF in blue, composite emission in green, LINER in orange, and Seyfert in red. NGC 1566, which has an uncertain nuclear emission type, is represented in grey.

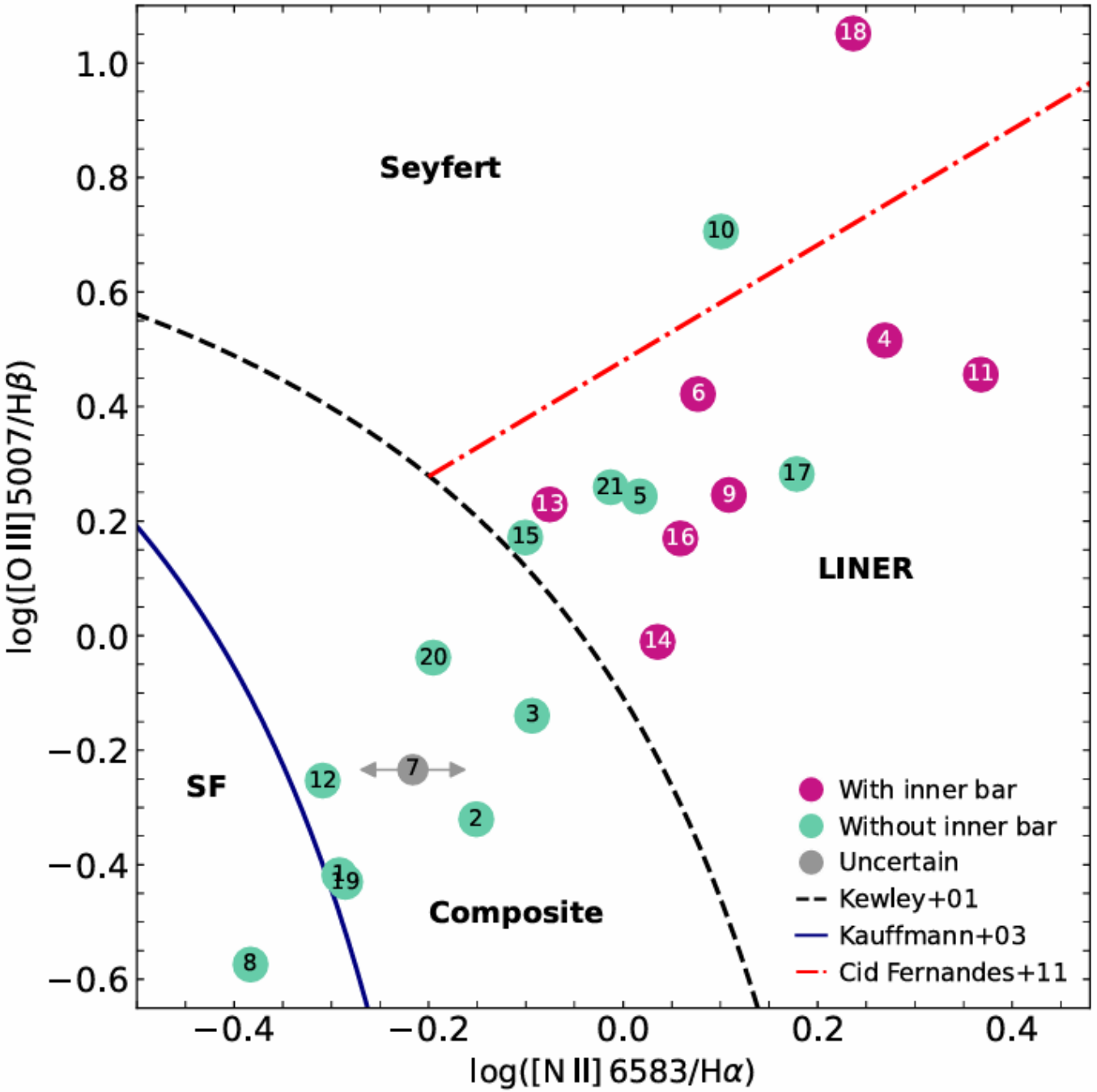
Результаты

- 11 out of 21 galaxies in our sample (∼52%) exhibit extended shock signatures within their inner kiloparsec
- Galaxies in the “coherent shocks” and “broken shocks” classes show deprojected residual-velocity magnitudes of 50 kms−1 or more across the shock features, consistent with models of bar driven shocks
- Most galaxies exhibiting large deprojected residual velocity magnitudes also have large average gas velocity dispersions within their inner kpc. This suggests that extended shocks contribute to turbulence in the host galaxy

Результаты

- The two unbarred galaxies in our sample are the only galaxies with unperturbed kinematic maps, showing no evidence of shock activity. Значит бары сильно влияют на возникновение ударных волн

- The nuclear emission in galaxies with inner bars is either of LINER- or of Seyfert-type, while in galaxies without inner bars it shows no preference, with star-forming or composite emission equally likely. Inner bars suppress SF activity in the innermost regions of galaxies.



Результаты

- Approximately 75% of galaxies with nuclear rings exhibit signatures of extended shocks. In four galaxies exhibiting signatures of extended shocks, we can trace the signatures to radii inside the ring, whereas in three of them the nuclear ring appears as a structural barrier, with the shock signatures detected only up to the ring itself.

The observed trends support the concept of gas inflow along the bars contributing to the formation of the nuclear rings within the inner kpc of the galaxies.