

# 20250701 NII and SII BPT Comparison.md

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## 1. 4 catalogs

I have the QC for each line:  $\text{FLUX}/\text{FLUX}_{\text{ERR}} \geq 3$  and  $\text{FLUX} \geq 20 \times 10 \text{ erg/s/cm}^2$ .

Now I have divided all non-nan spaxels into 4 catalogs (here I use [NII] BPT as an example):

1. `Unknown` (in color blue): not detected in Balmer lines, i.e., either H $\alpha$  or H $\beta$  or both does not pass the QC.
2. `Unconstrained` (in color red): detected in Balmer lines, but error bars are too large to locate the spaxel's position on the [NII] BPT diagram.
3. `Upper` (in color orange): detected in Balmer lines, constrained on [NII] BPT diagram, and above the Kewley+2001 curve (red curve).
4. `SF` (in color green): detected in Balmer lines, constrained on [NII] BPT diagram, and below the Kewley+2001 curve (red curve).

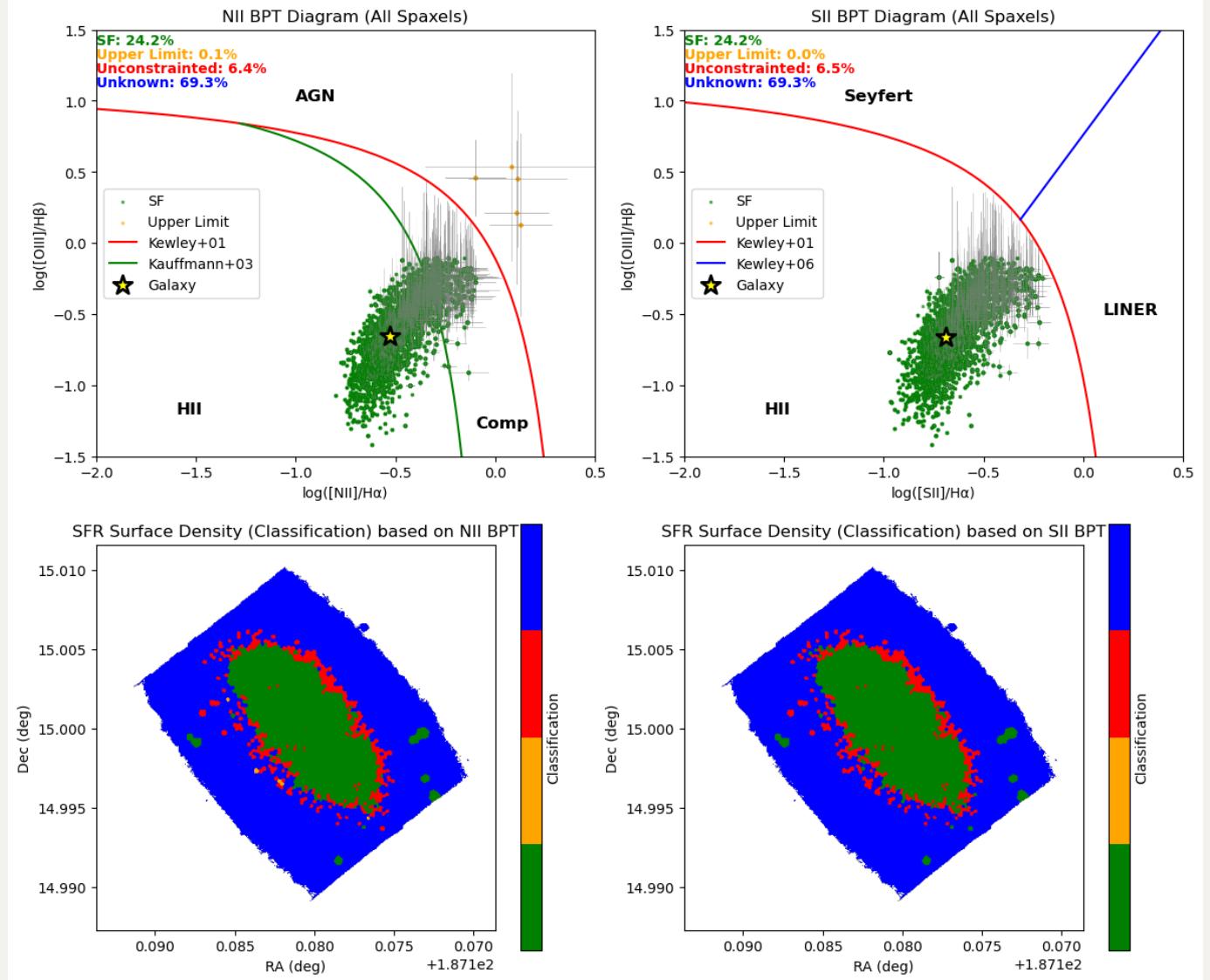
## 2. Comparison

Now I apply this classification for both [NII] and [SII] BPT diagrams to see any difference. As expected, most of galaxies have similar distributions across two BPT diagrams, but some of them are different. Here are three cases:

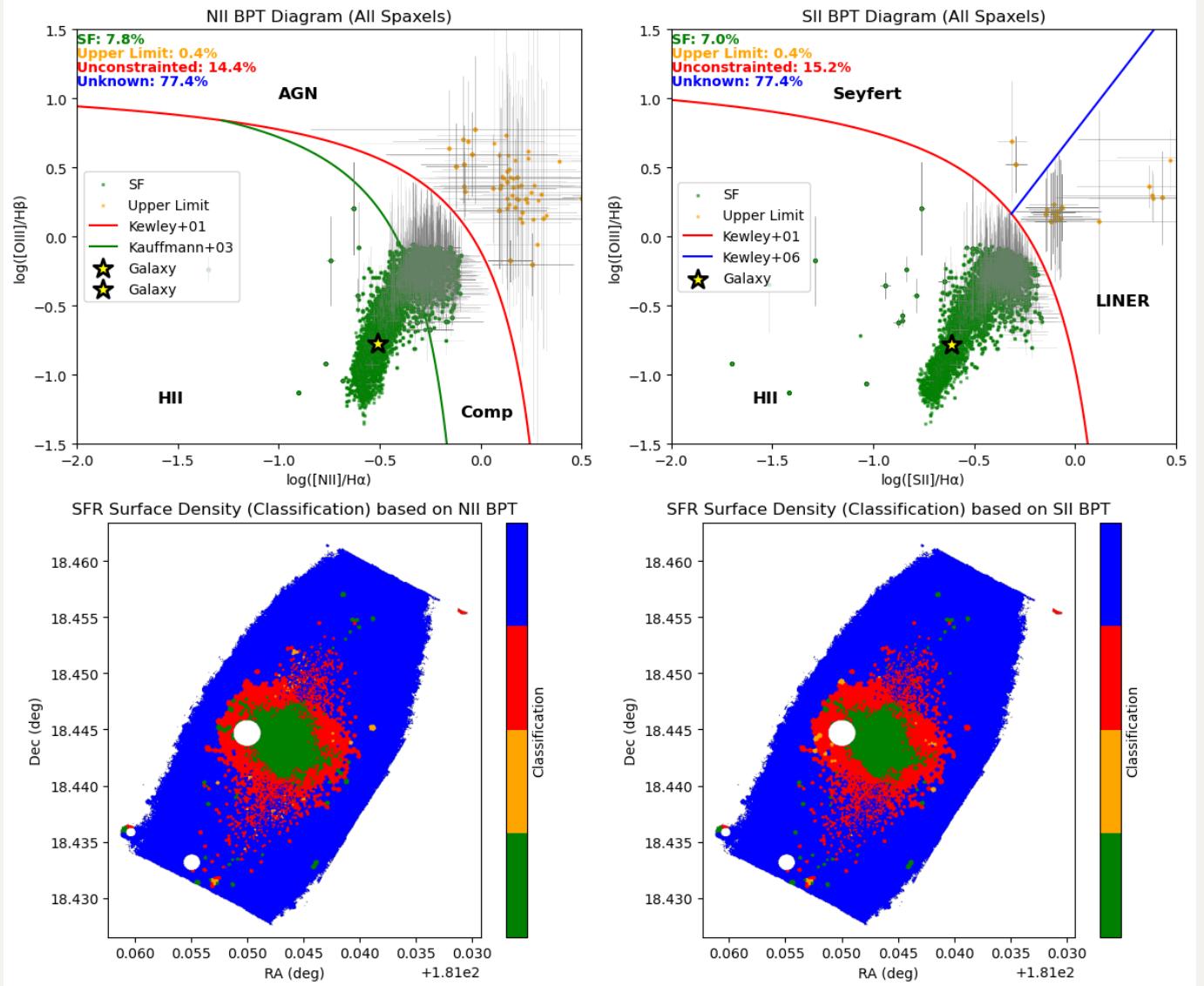
1. Similar distributions: IC3392, NGC4064, NGC4192, NGC4298, NGC4330, NGC4457, NGC4624
2. Differences in `Upper` (`Upper` regions appear in [NII] but become `Unconstrained` in [SII] BPT diagram): NGC4293 (the biggest differences), NGC4419, NGC4501, NGC4698
3. Differences in `SF` (extended `SF` regions in [NII] compared to [SII] BPT diagram): NGC4383 (the biggest differences), NGC4396, NGC4522

Meanwhile, I am still trying to understand the physics behind the ionization of these two lines, but here I show the details of each galaxy.

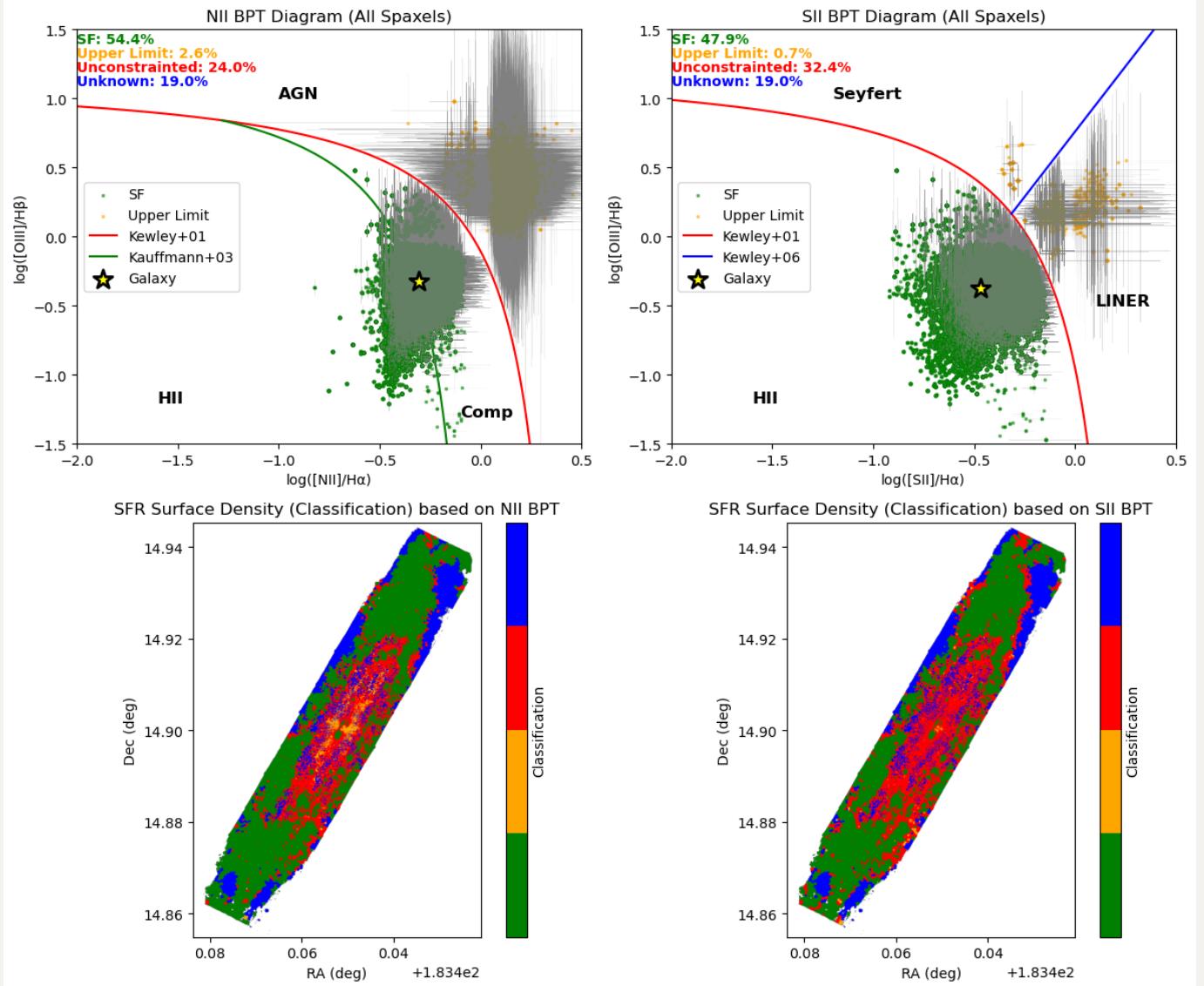
## 2.1 IC3392



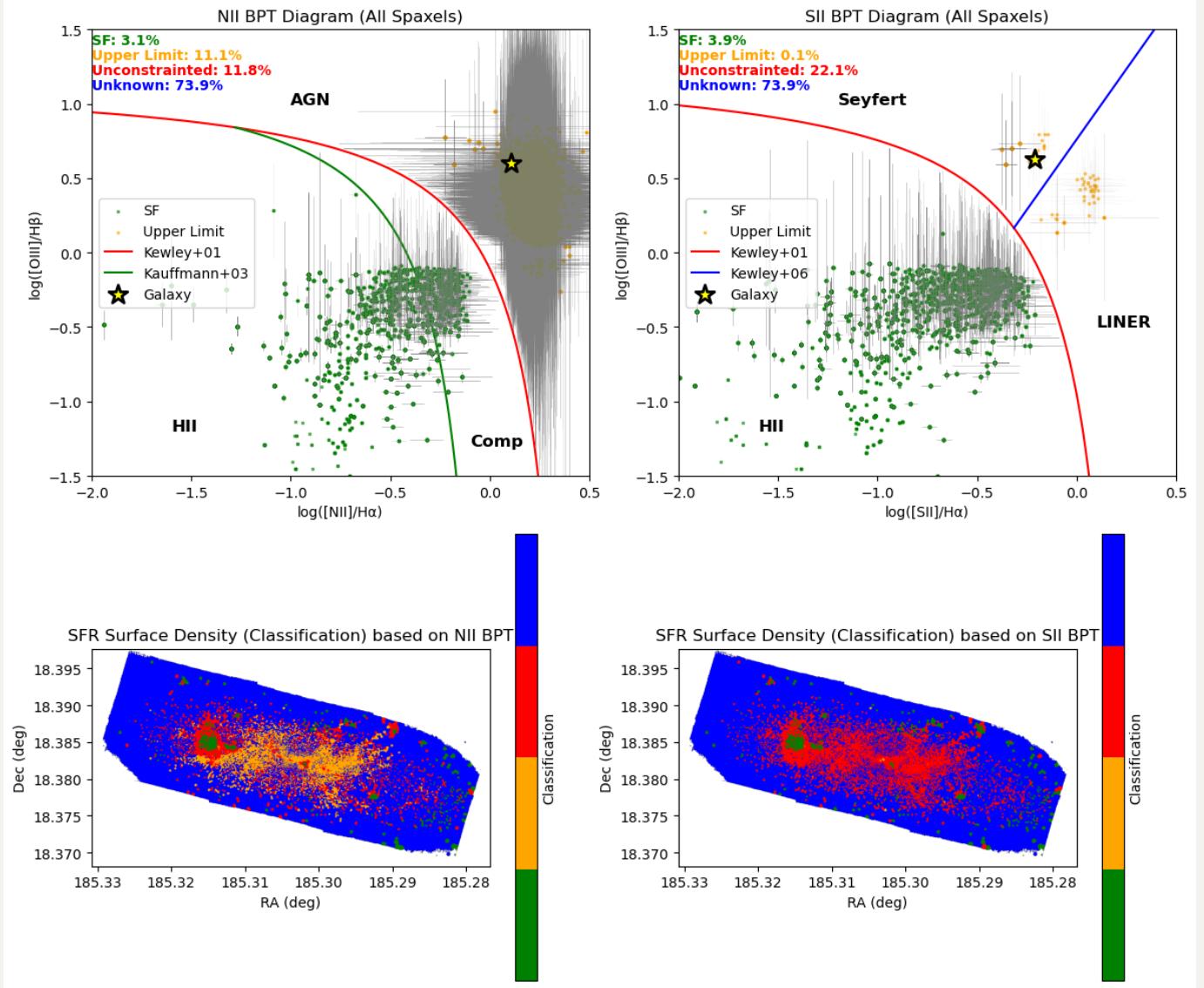
## 2.2 NGC4064



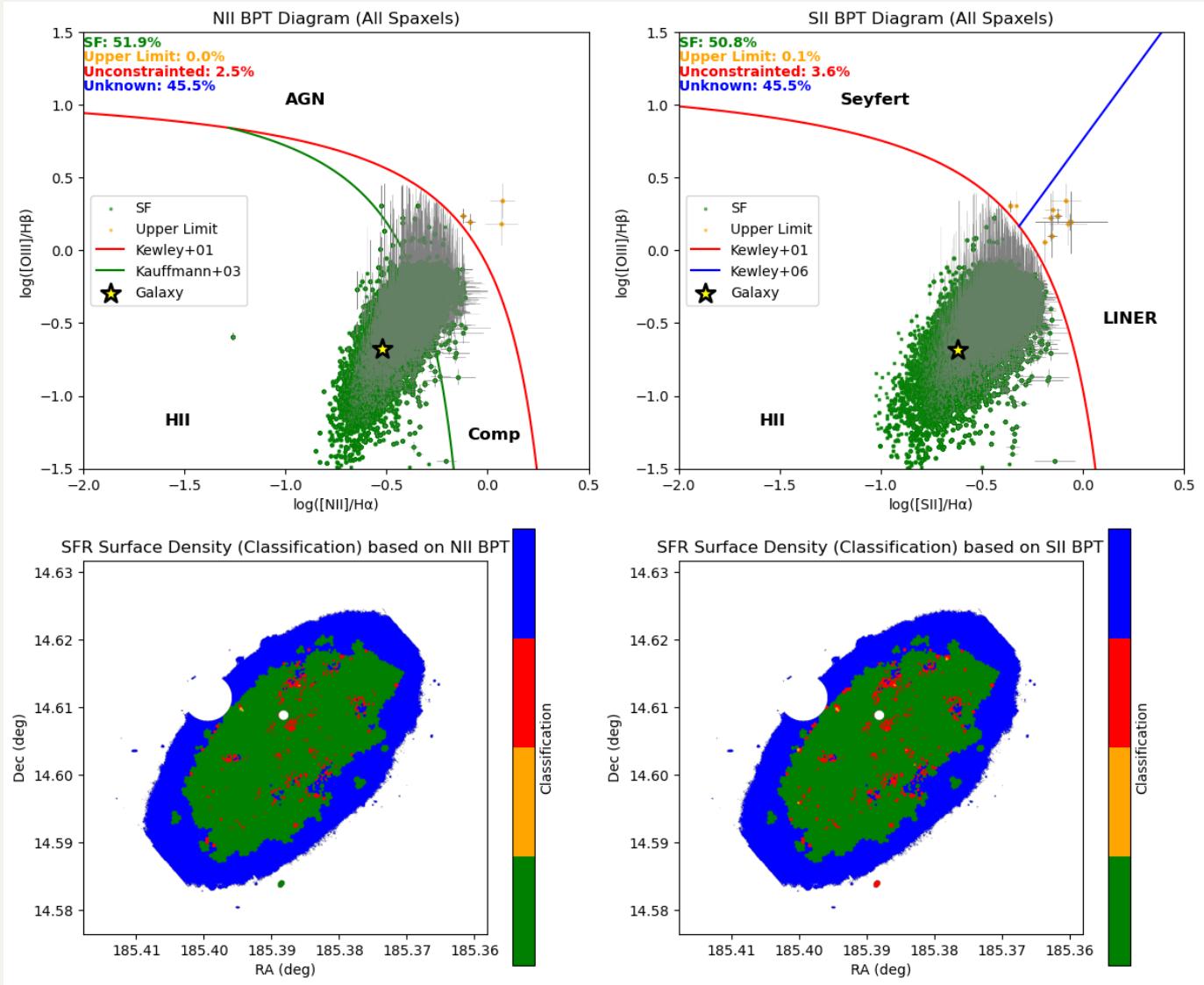
## 2.3 NGC4192



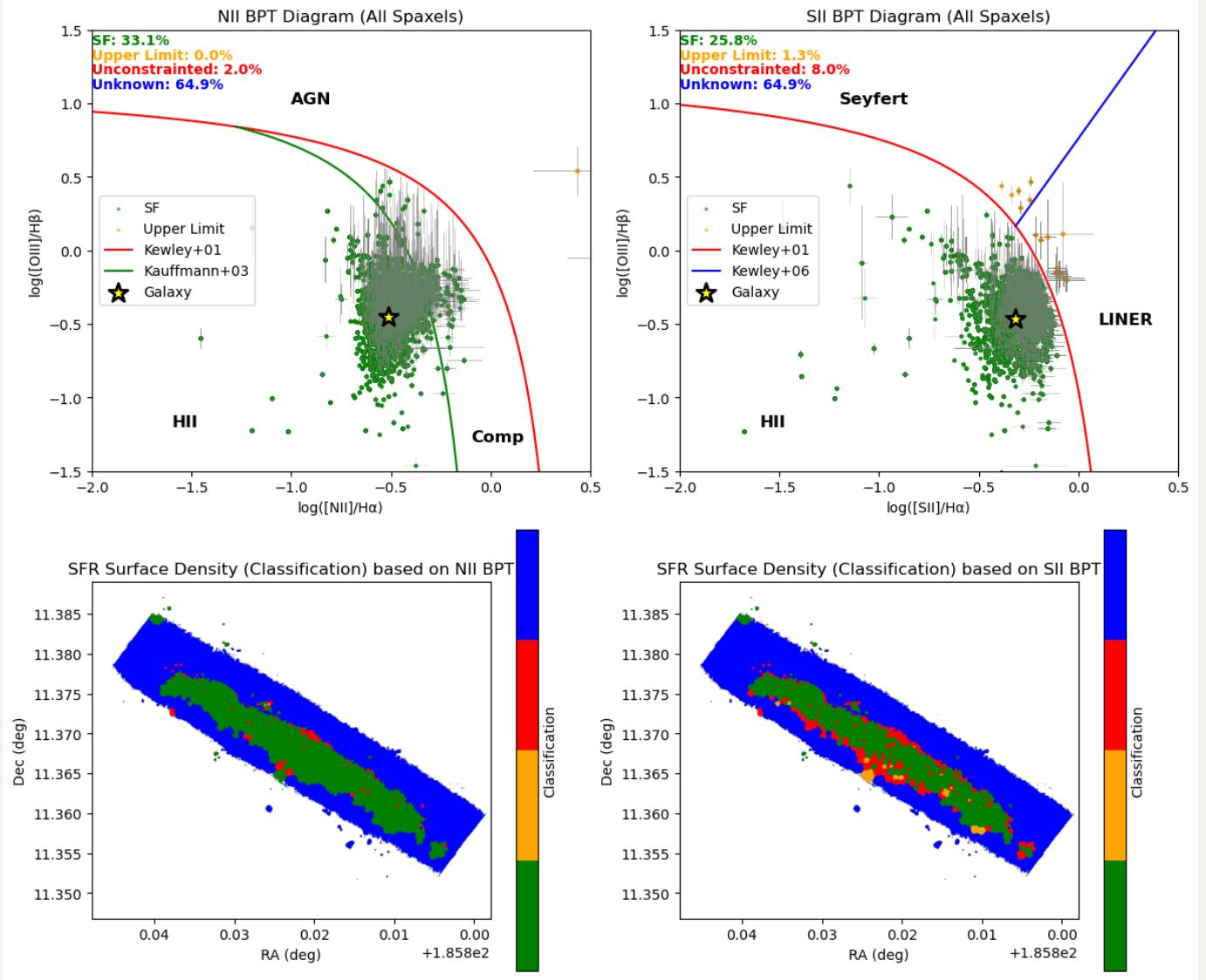
## 2.4 NGC4293



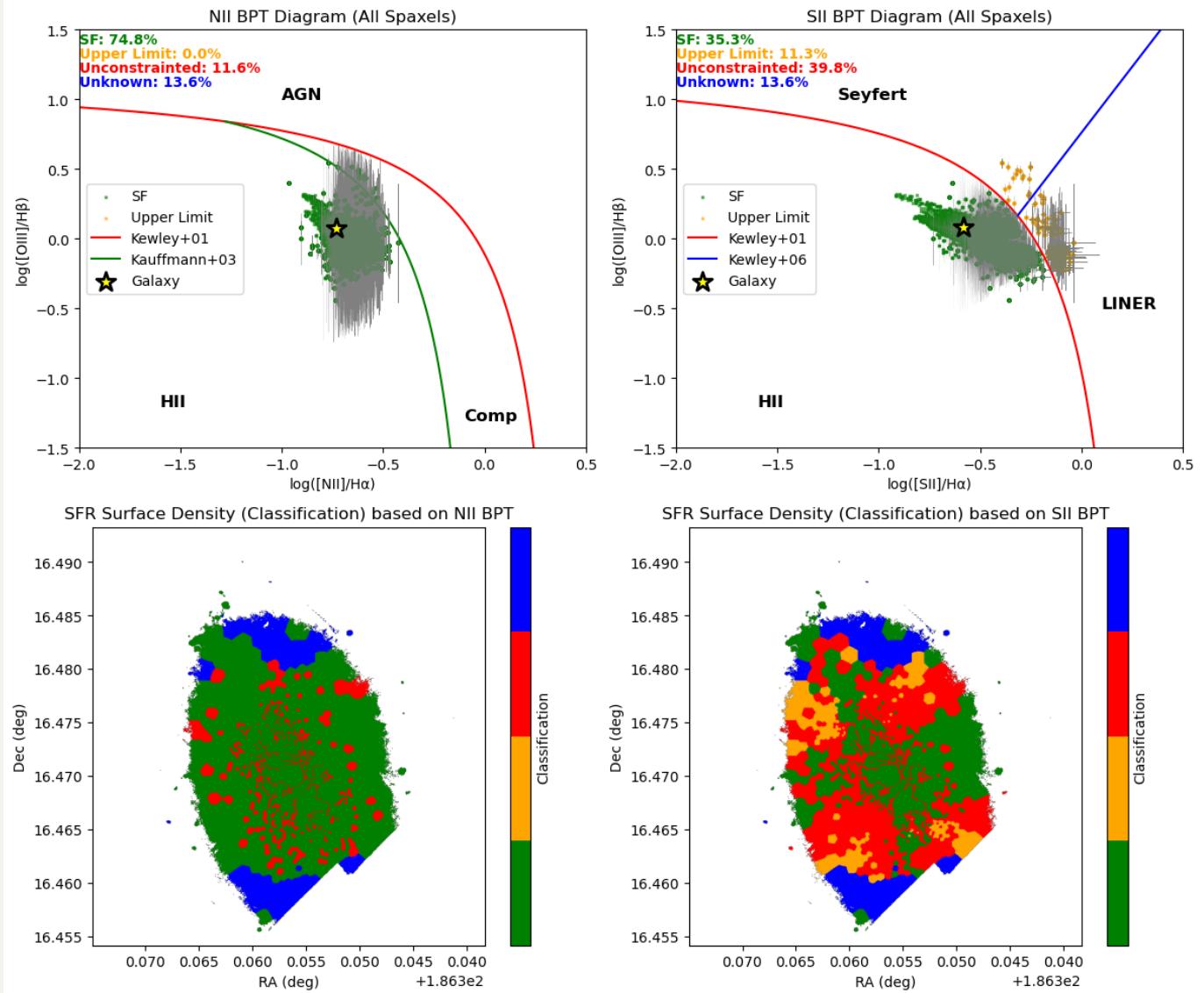
2.5 NGC4298



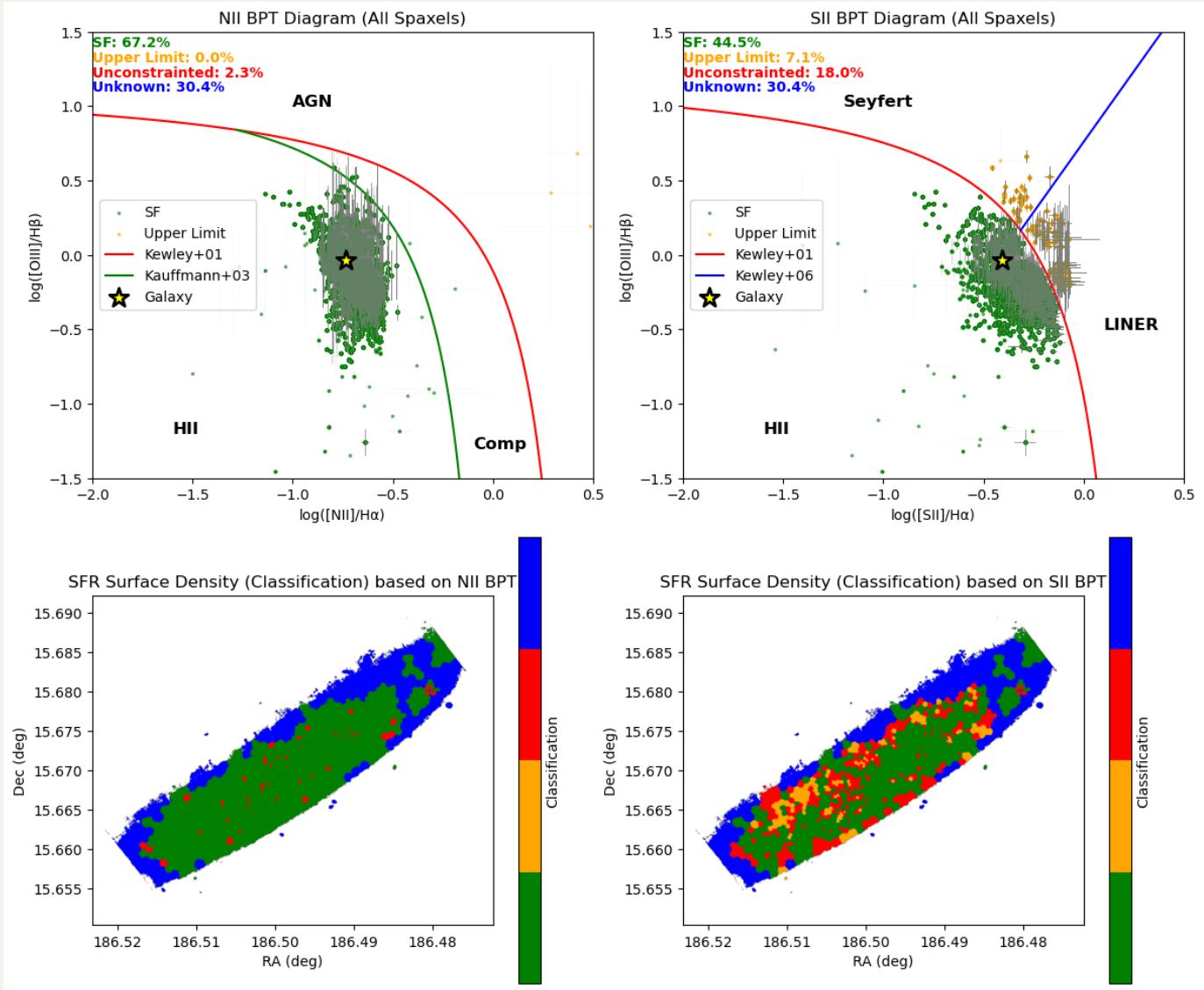
## 2.6 NGC4330



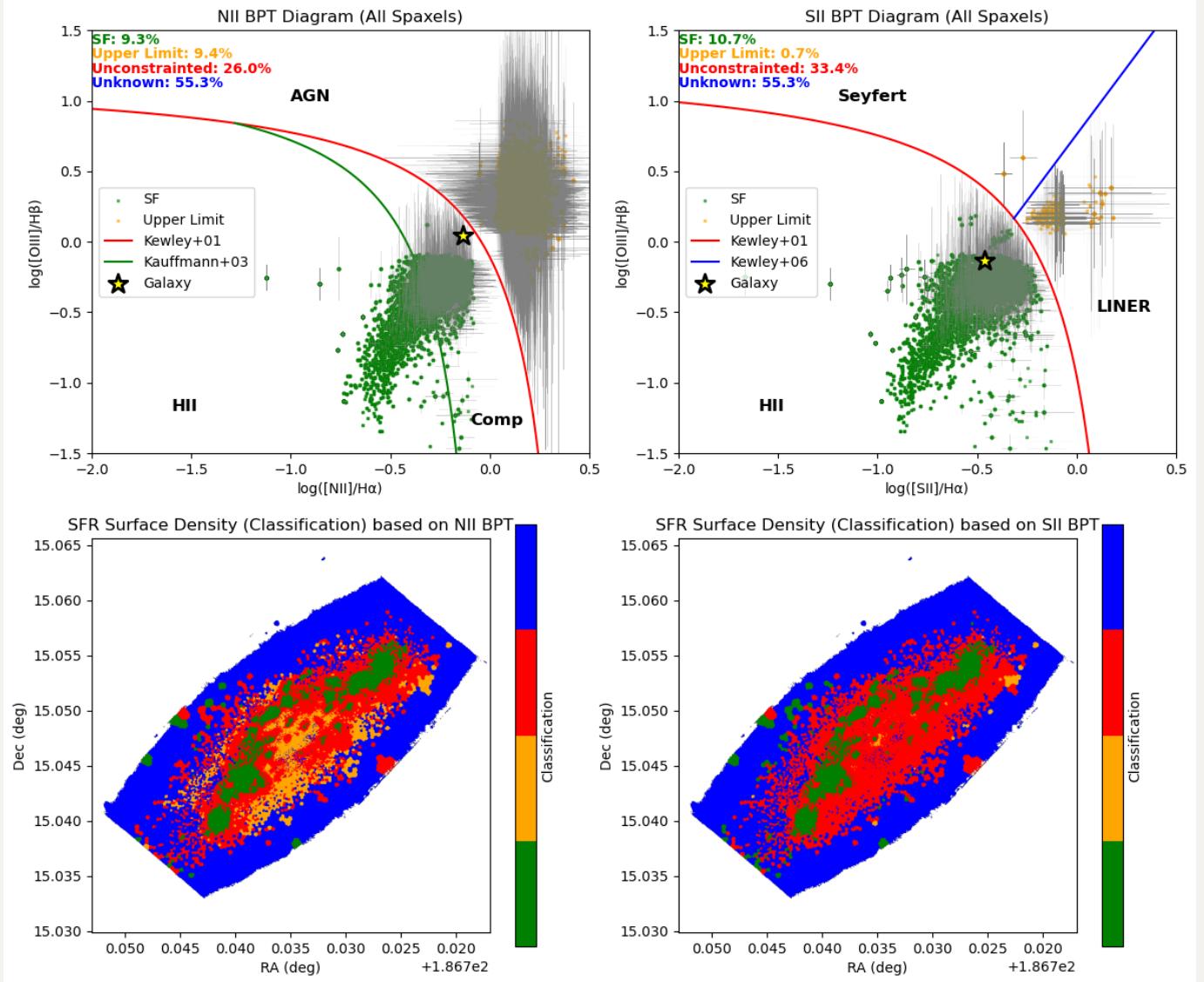
## 2.7 NGC4383



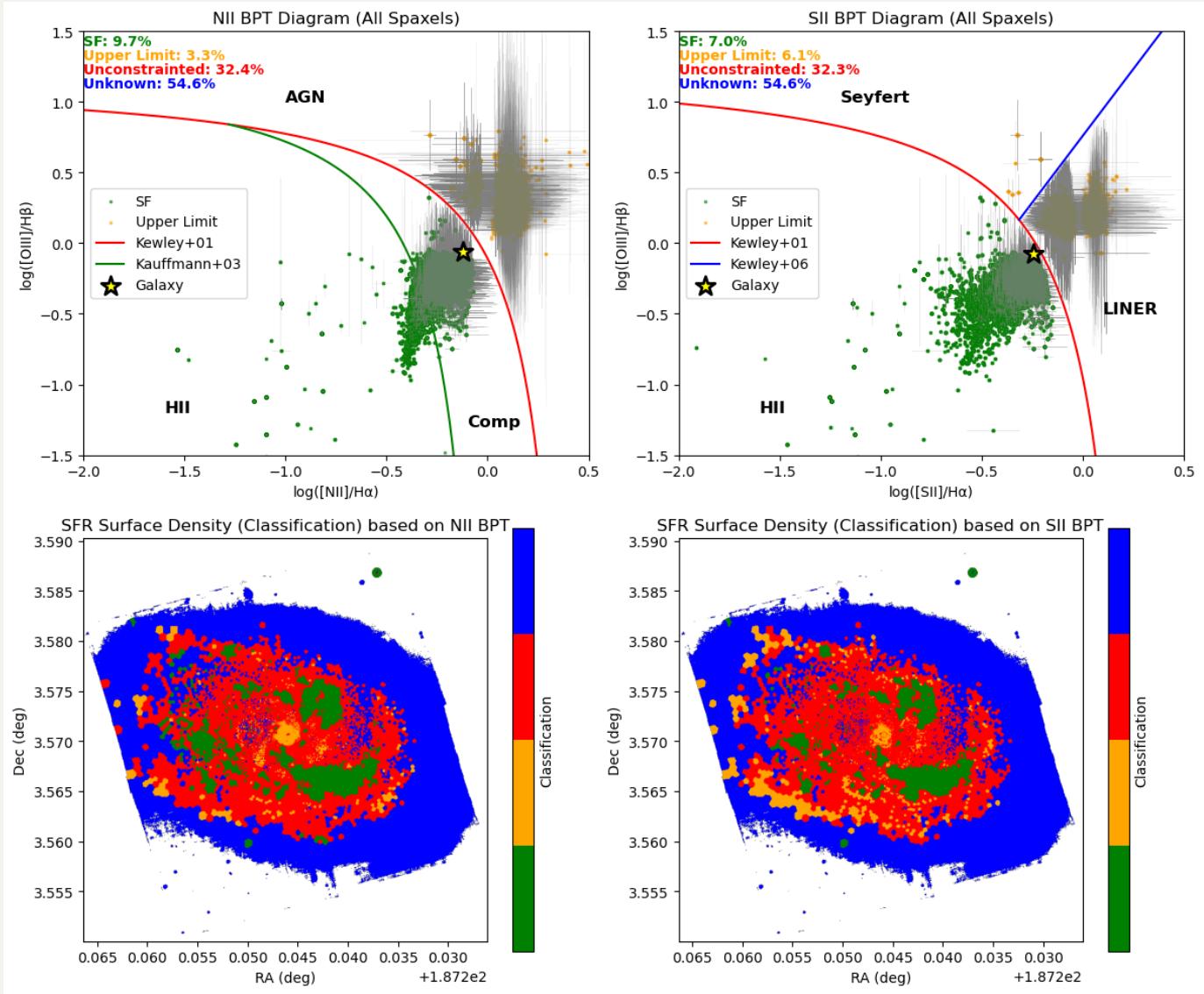
## 2.8 NGC4396



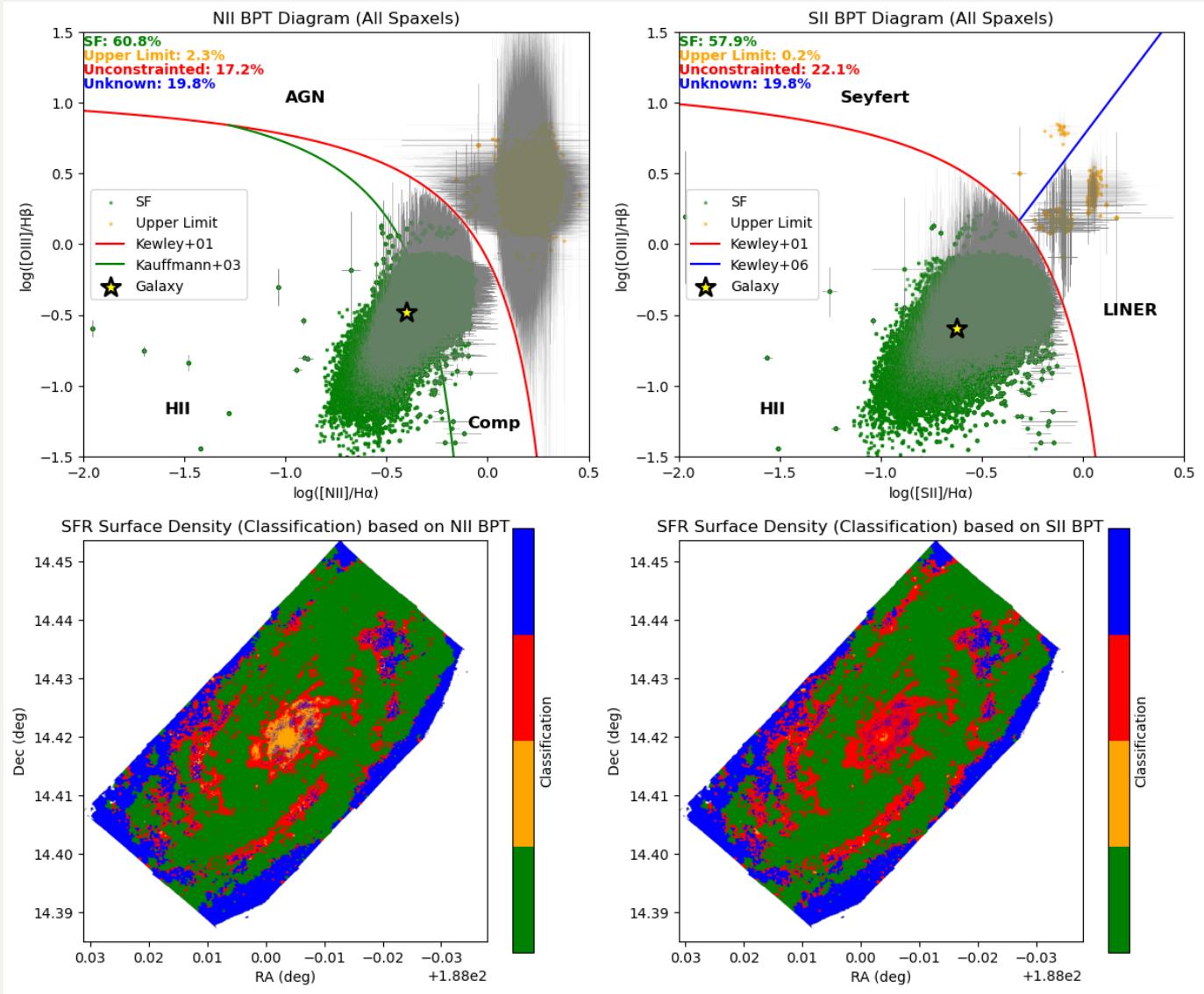
## 2.9 NGC4419



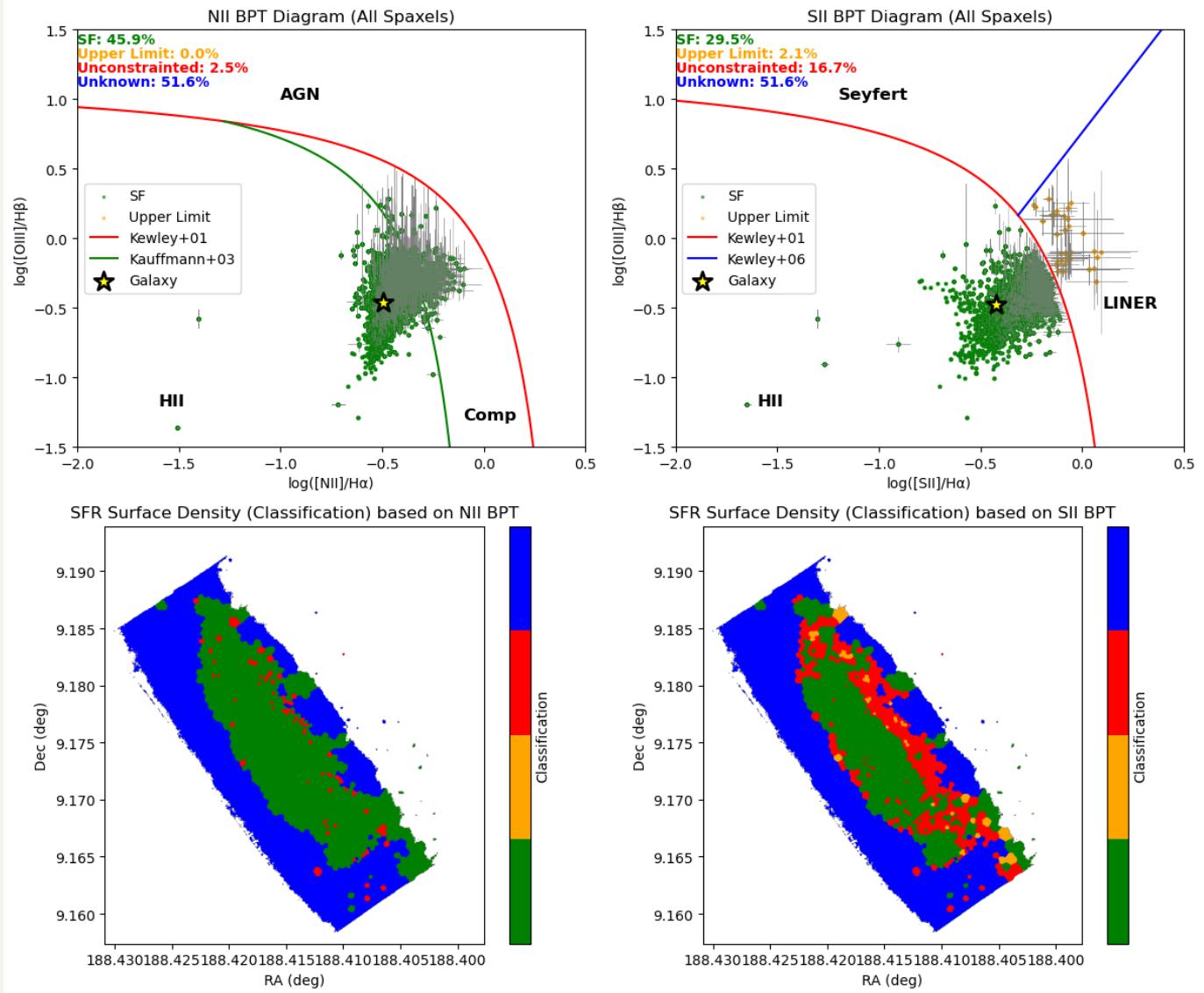
## 2.10 NGC4457



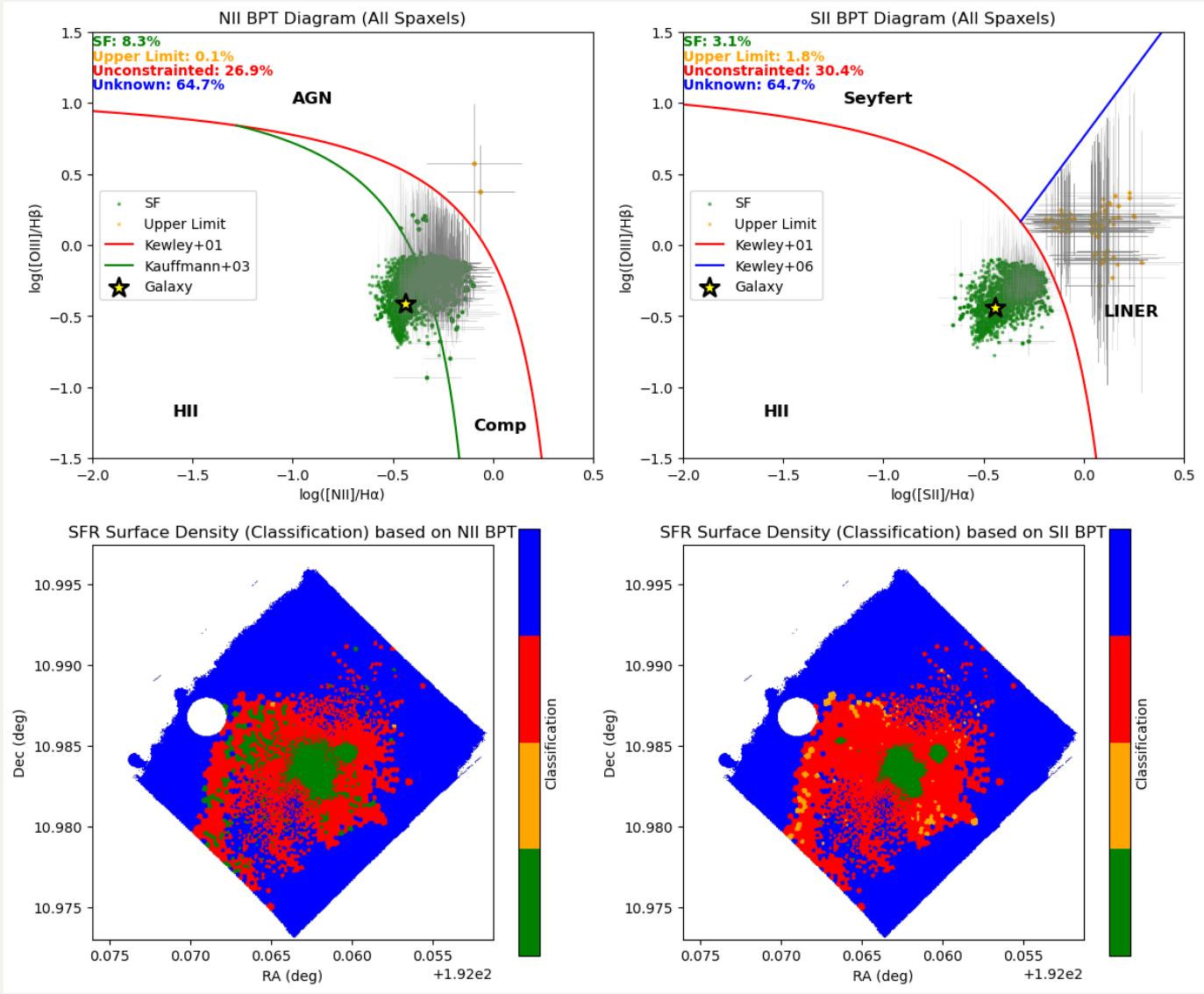
## 2.11 NGC4501



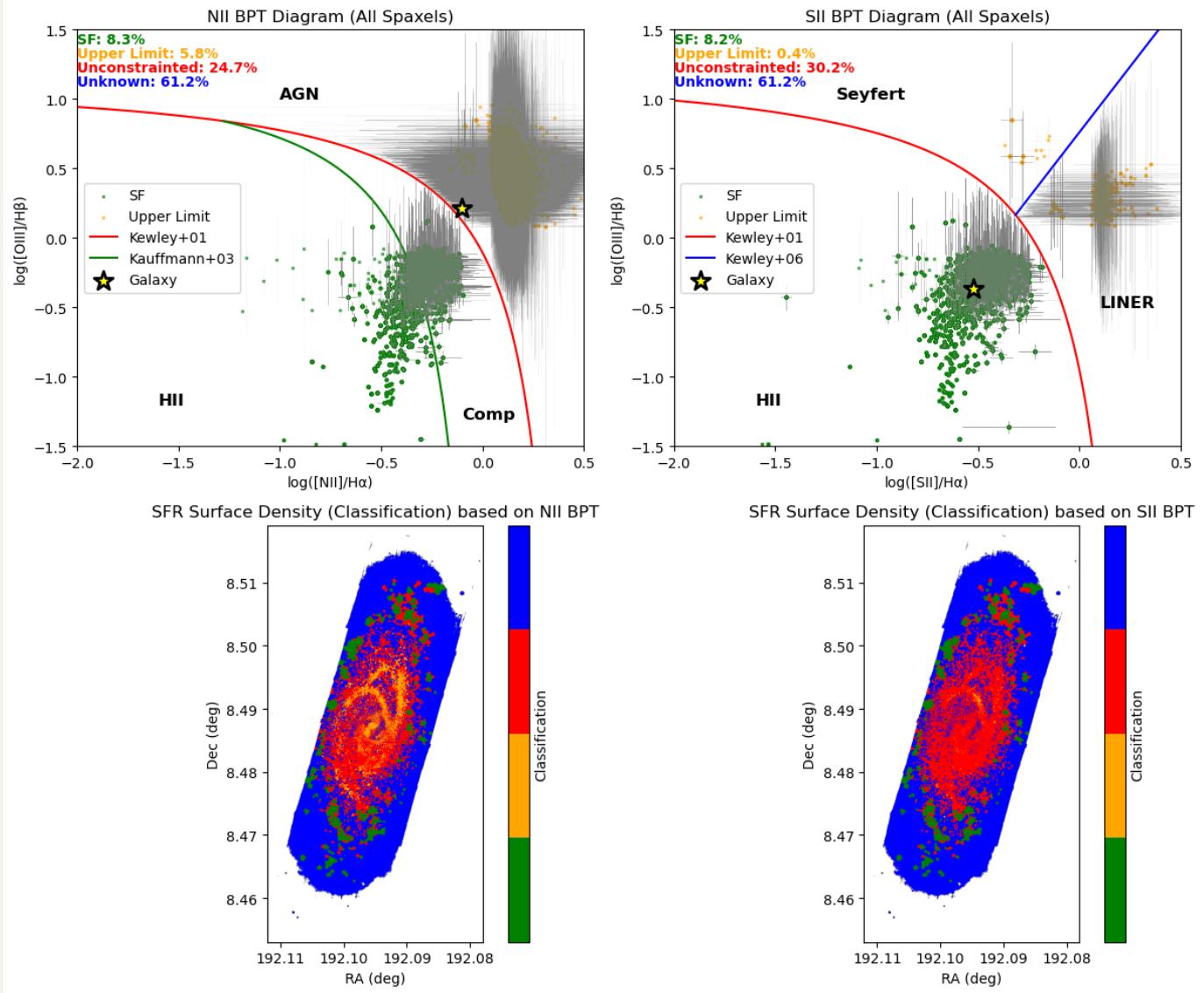
2.12 NGC4522



## 2.13 NGC4694



2.14 NGC4698



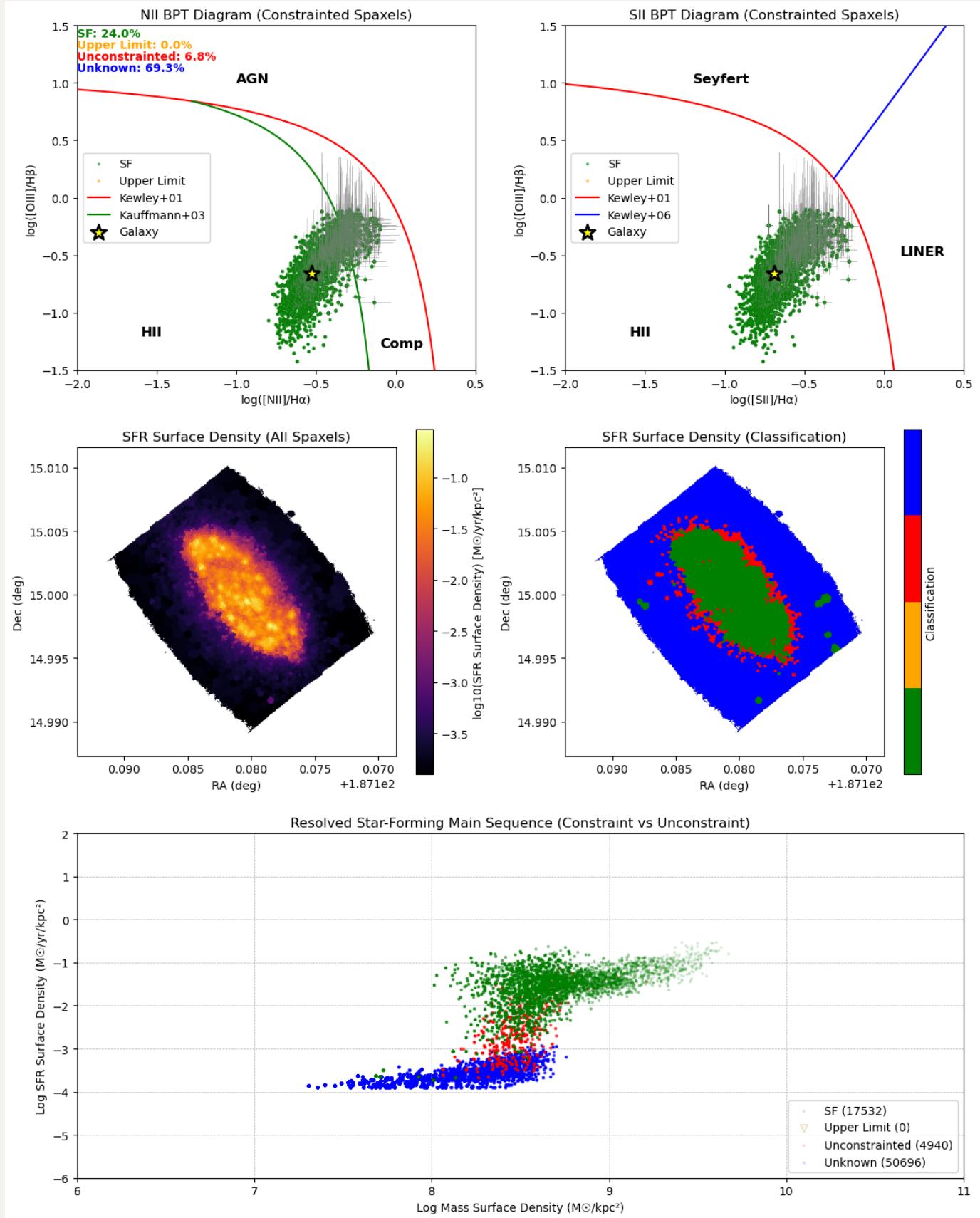
### 3. Together

To put these two BPT selections together, the current approach I use is to make sure each spaxel is classified on both BPT diagrams. That means:

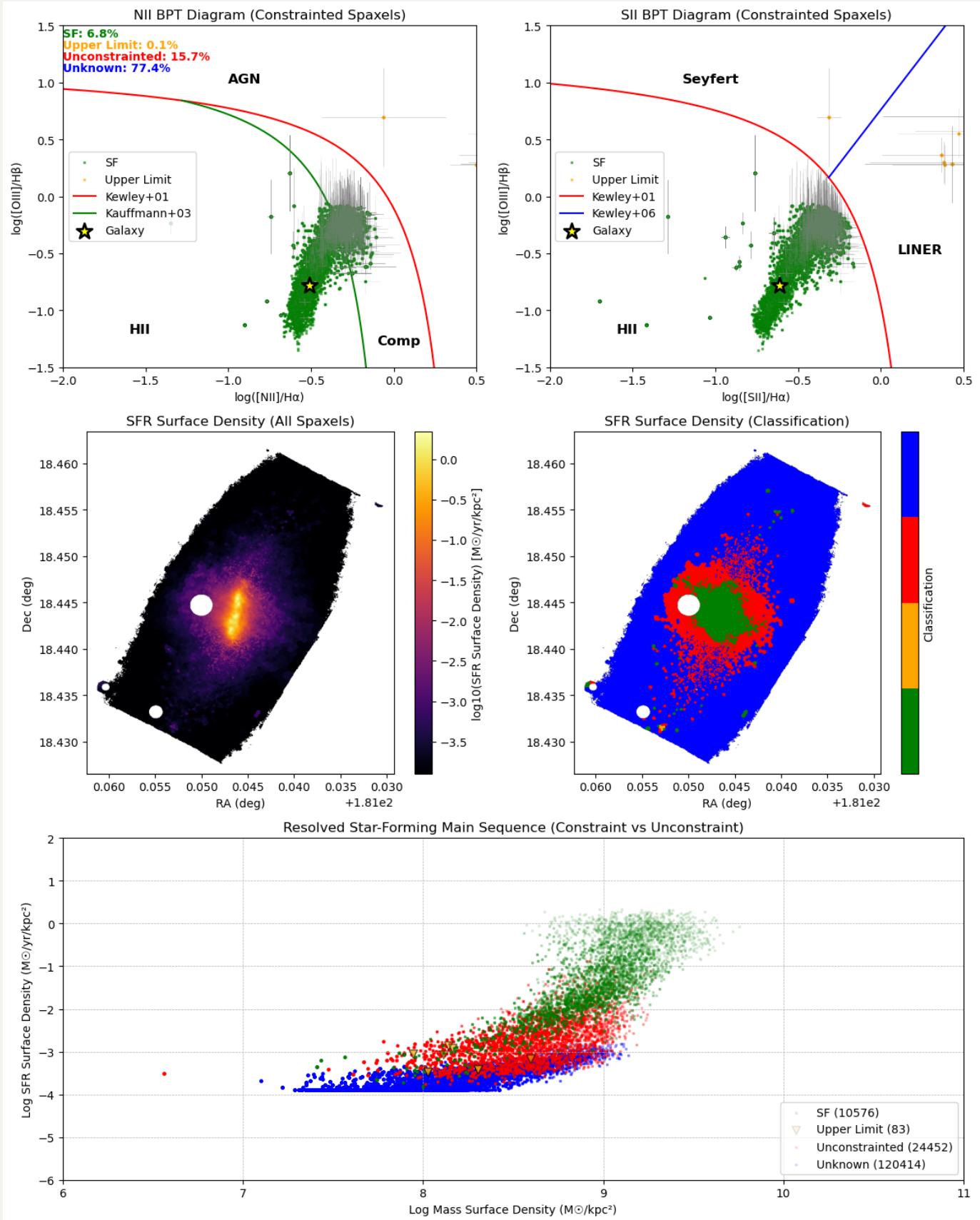
1. **Unknown**: still not detected in Balmer lines
2. **SF** (in color green): **SF** on both [NII] and [SII] BPT diagram simultaneously.
3. **Upper** (in color orange): detected in Balmer lines, constrained on both [NII] and [SII] BPT diagram simultaneously, but not **SF** on either [NII] or [SII] BPT diagram or both.
4. **Unconstrained** (in color red): detected in Balmer lines, but **Unconstrained** on either [NII] or [SII] BPT diagram or both.

Again, below are the details of applying the **both** selection on each galaxy.

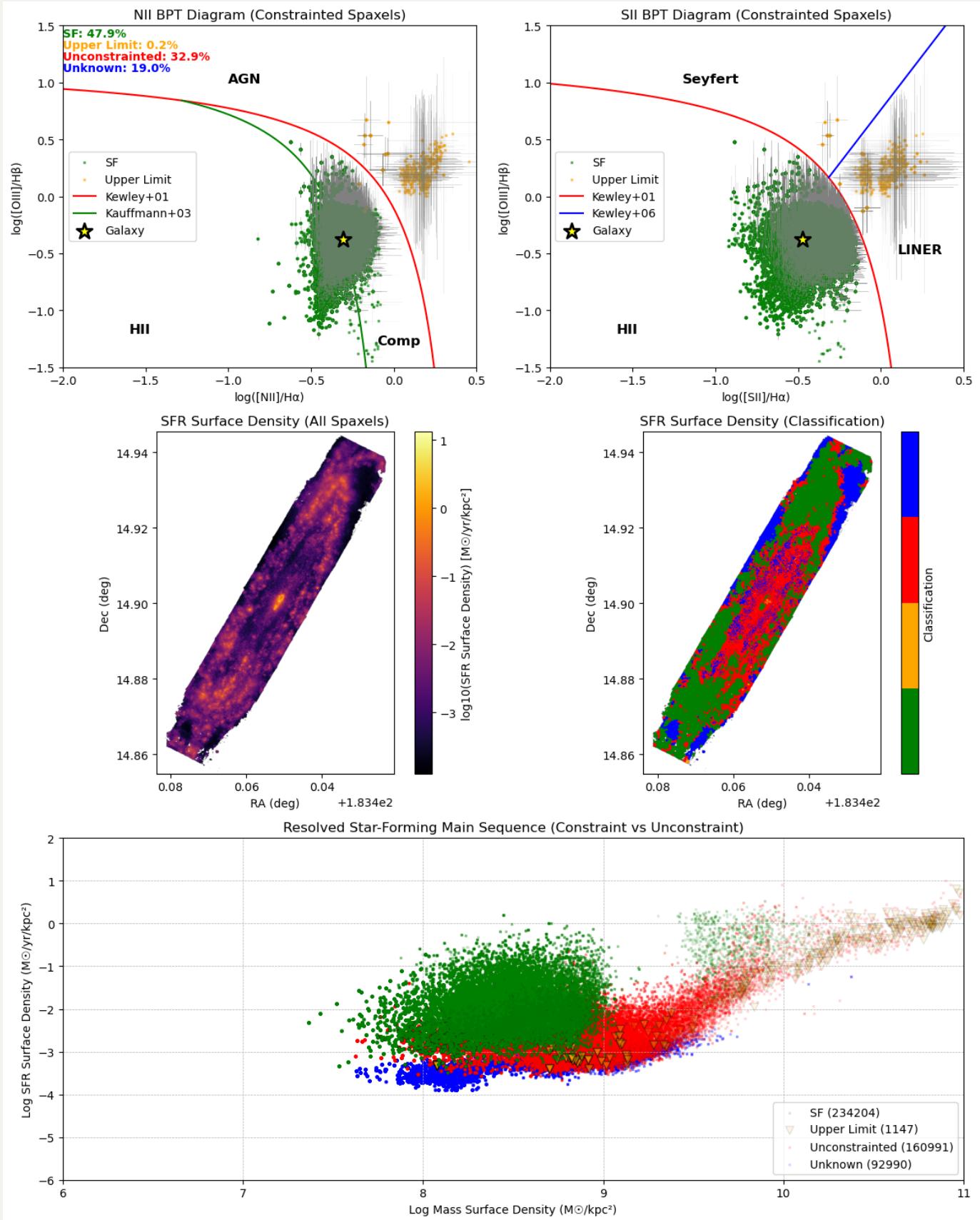
### 3.1 IC3392



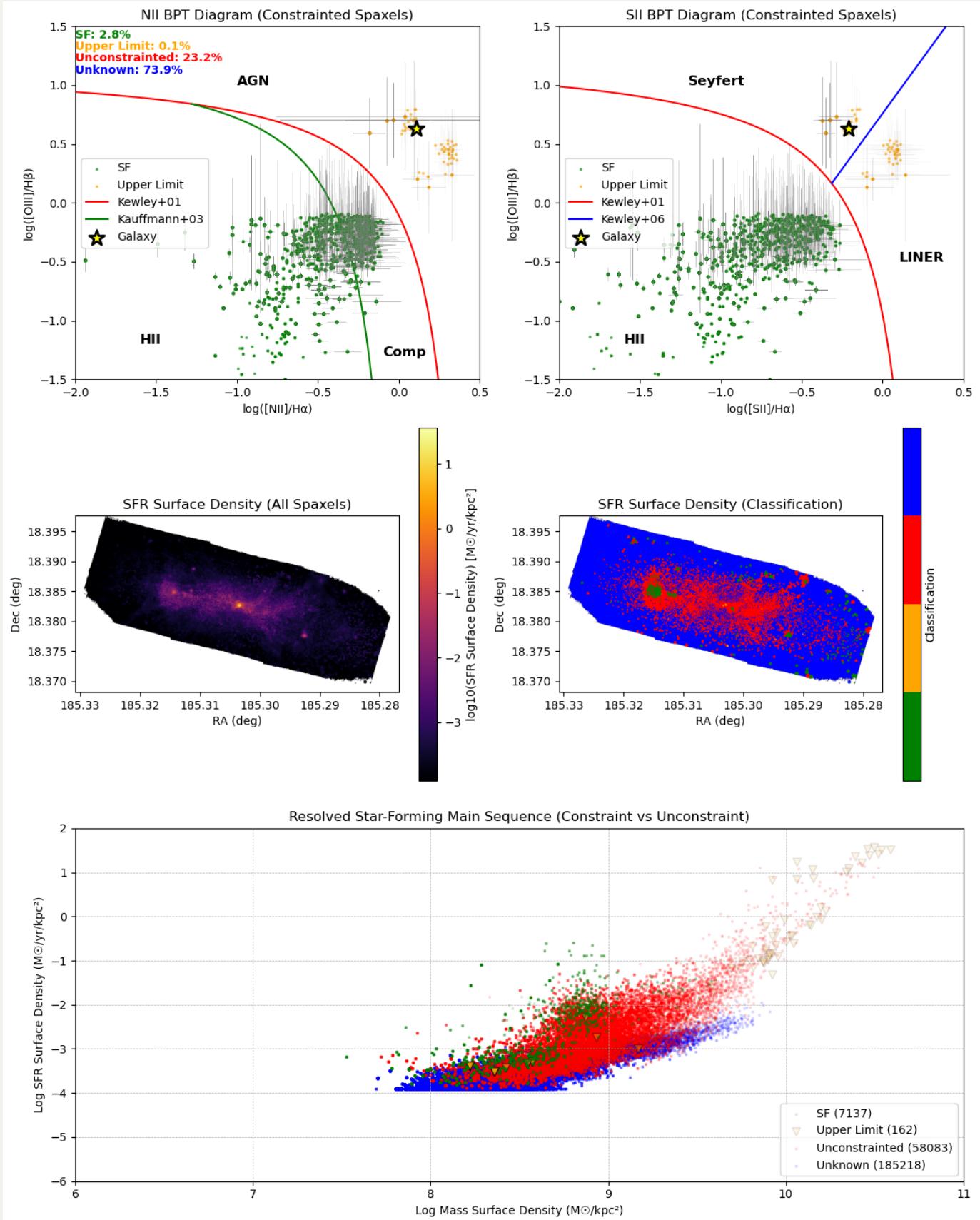
### 3.2 NGC4064



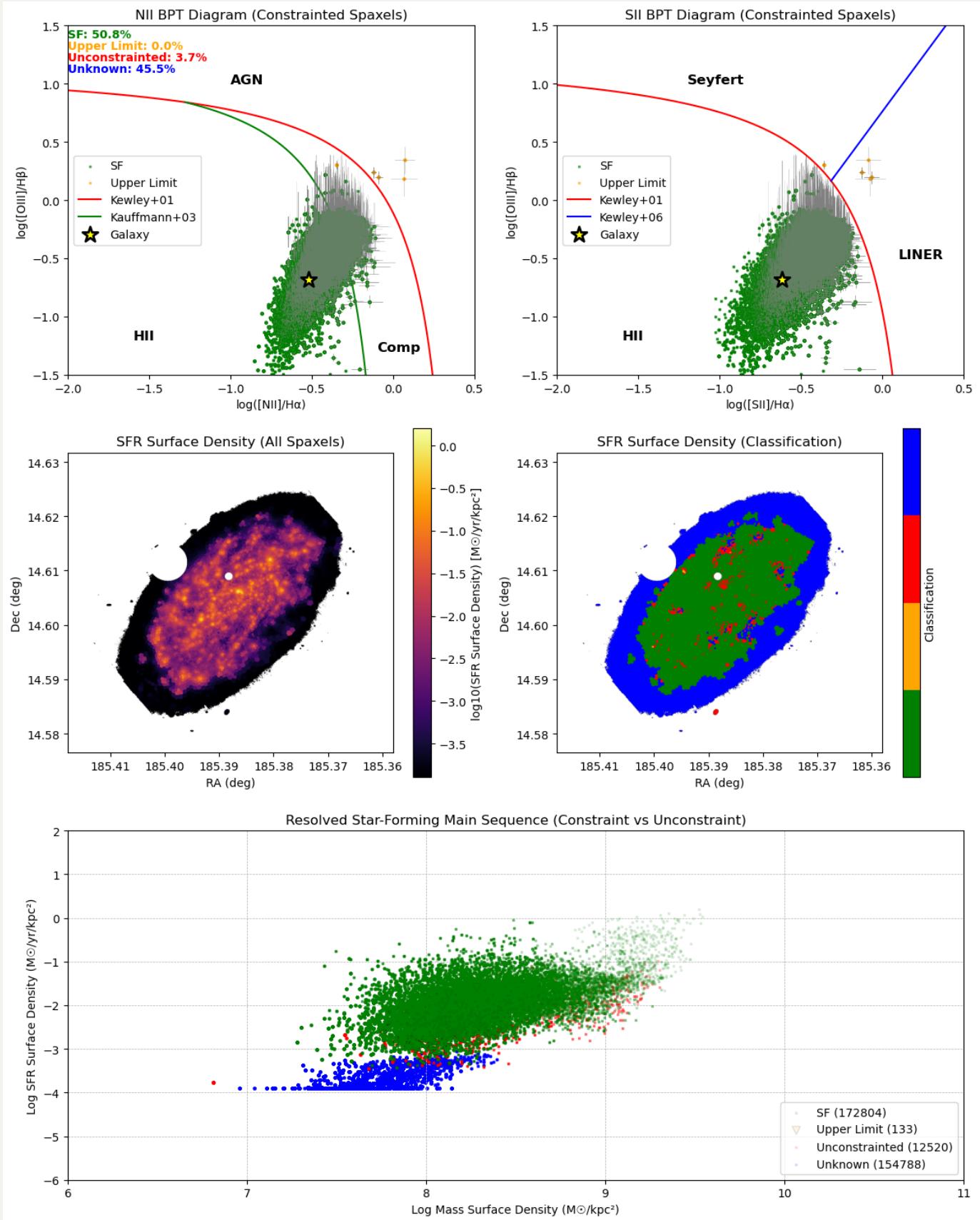
### 3.3 NGC4192



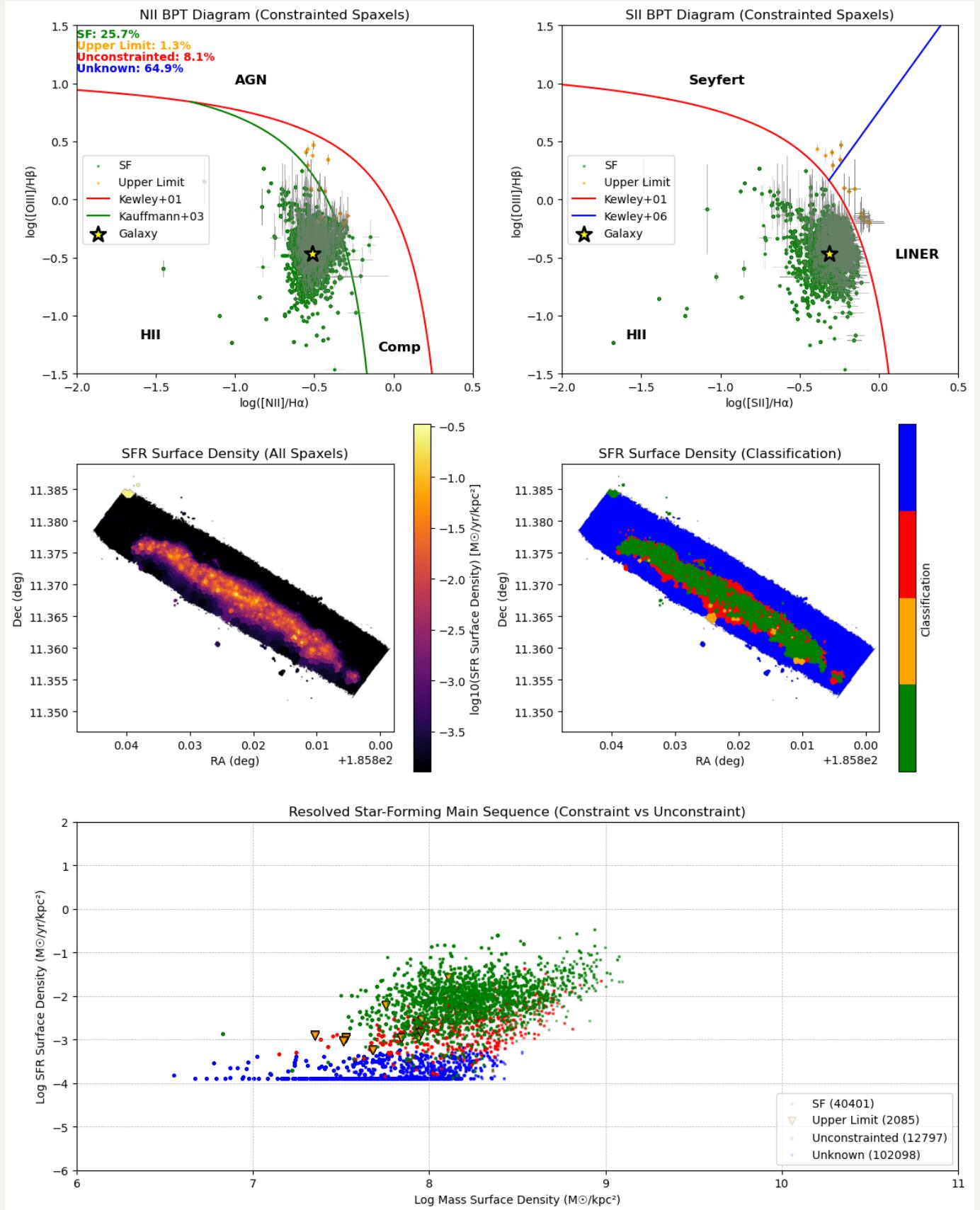
### 3.4 NGC4293



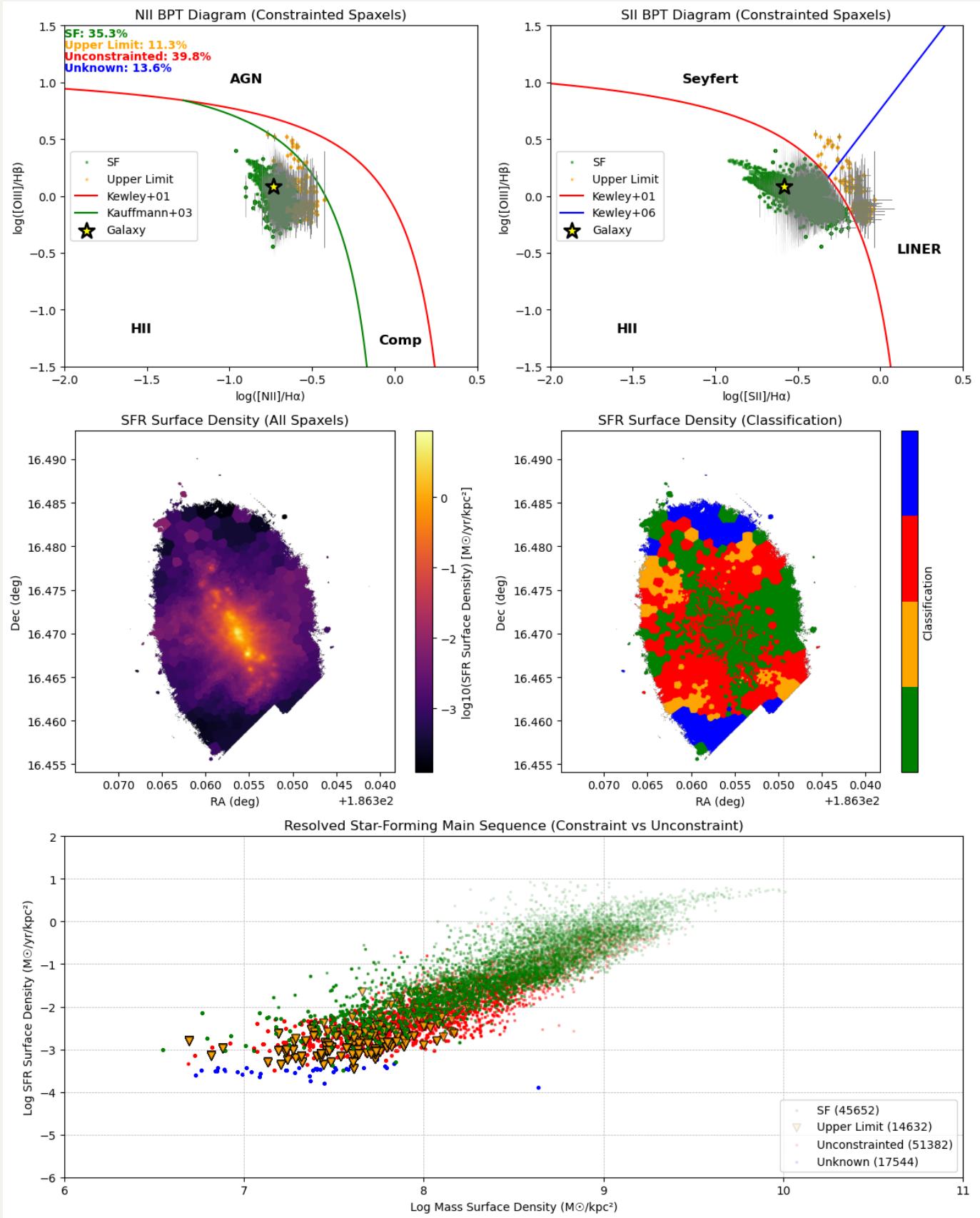
3.5 NGC4298



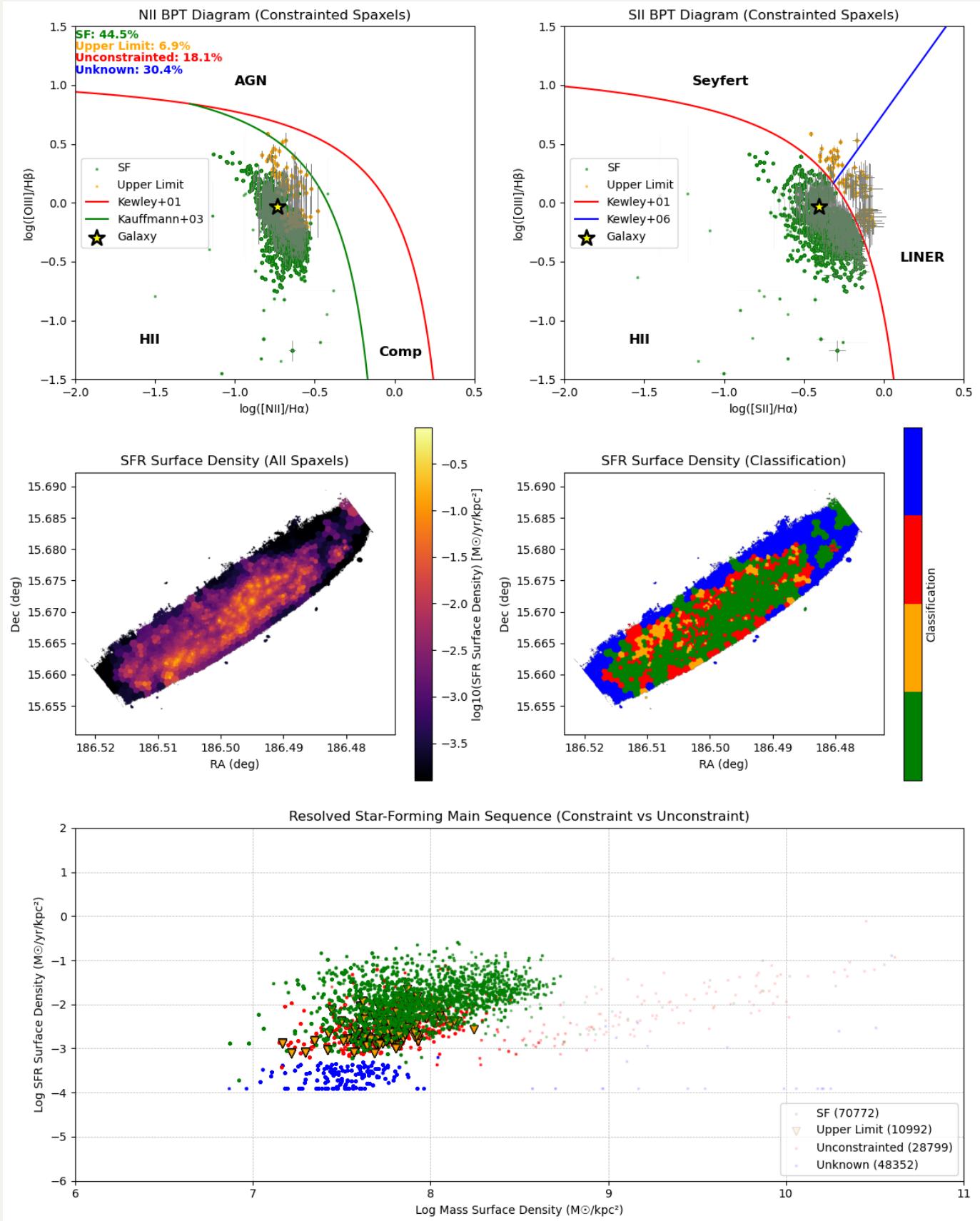
### 3.6 NGC4330



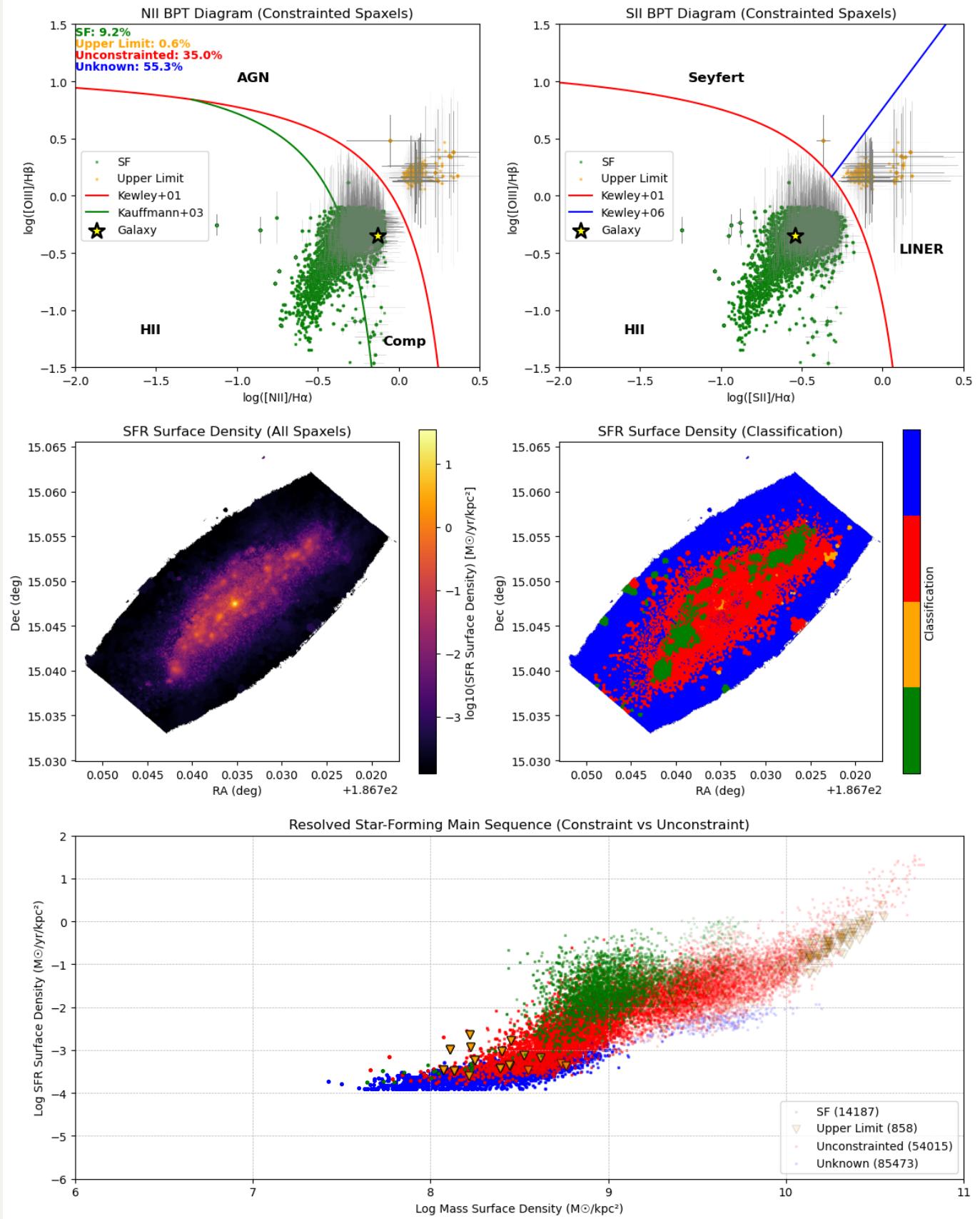
3.7 NGC4383



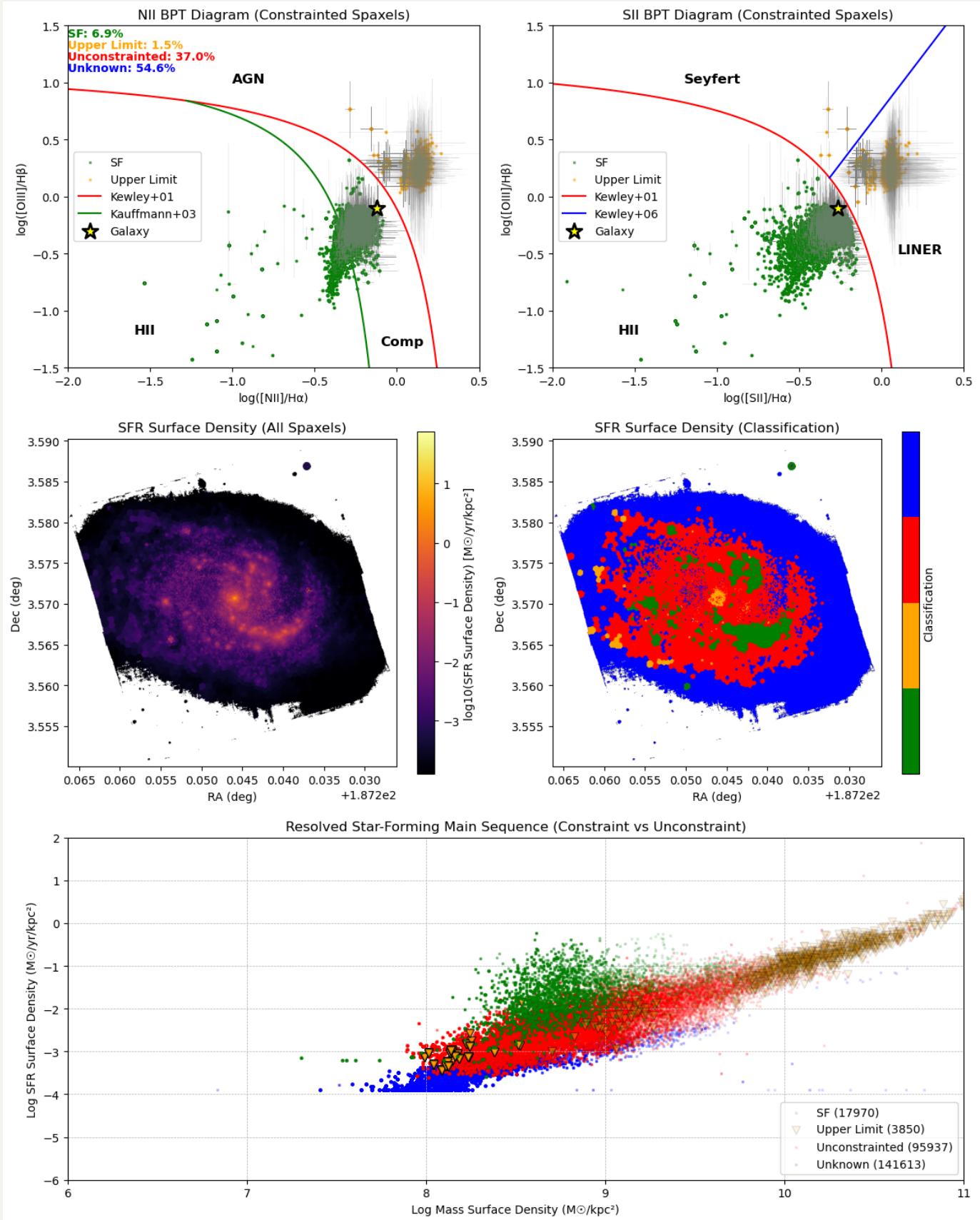
3.8 NGC4396



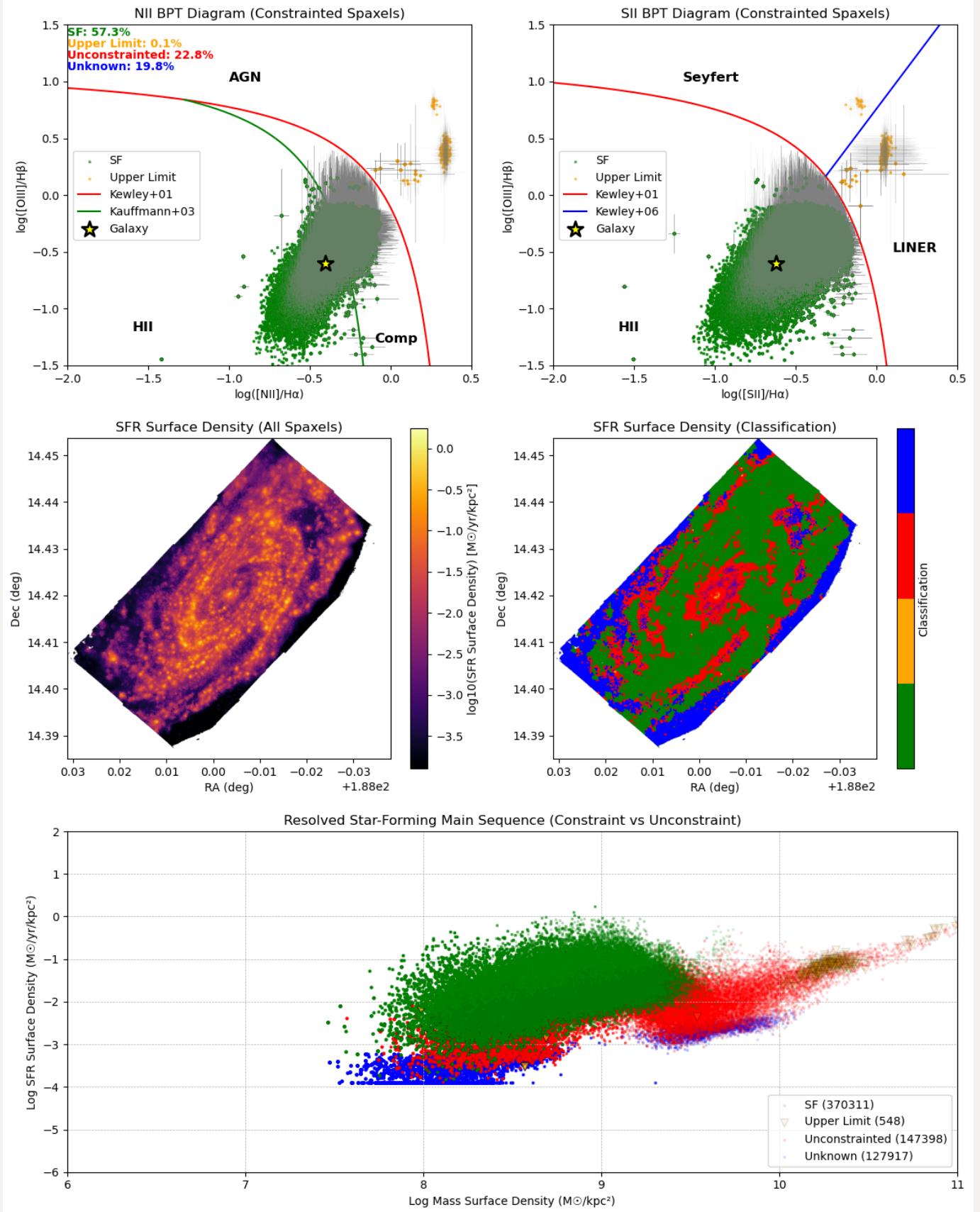
3.9 NGC4419



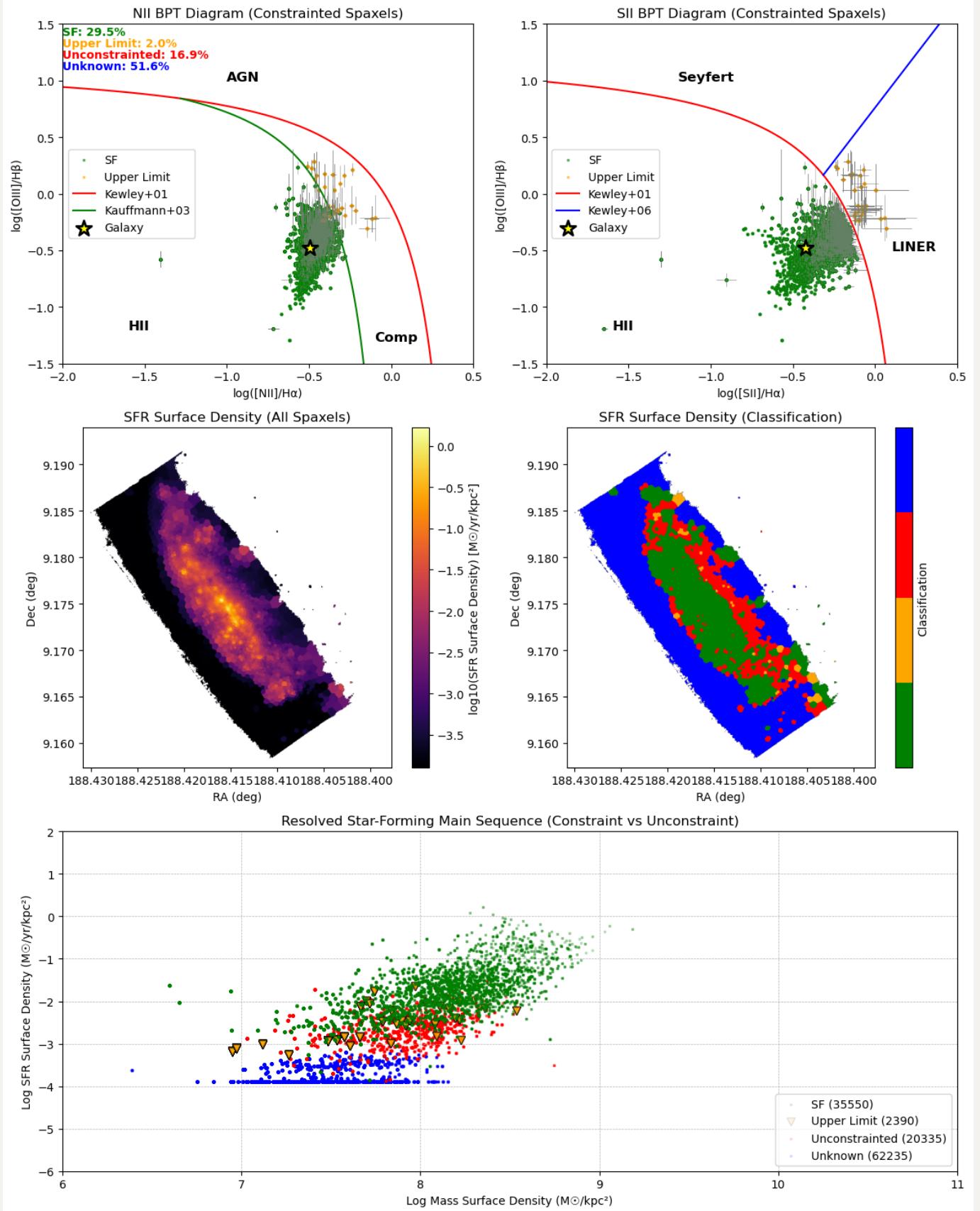
### 3.10 NGC4457



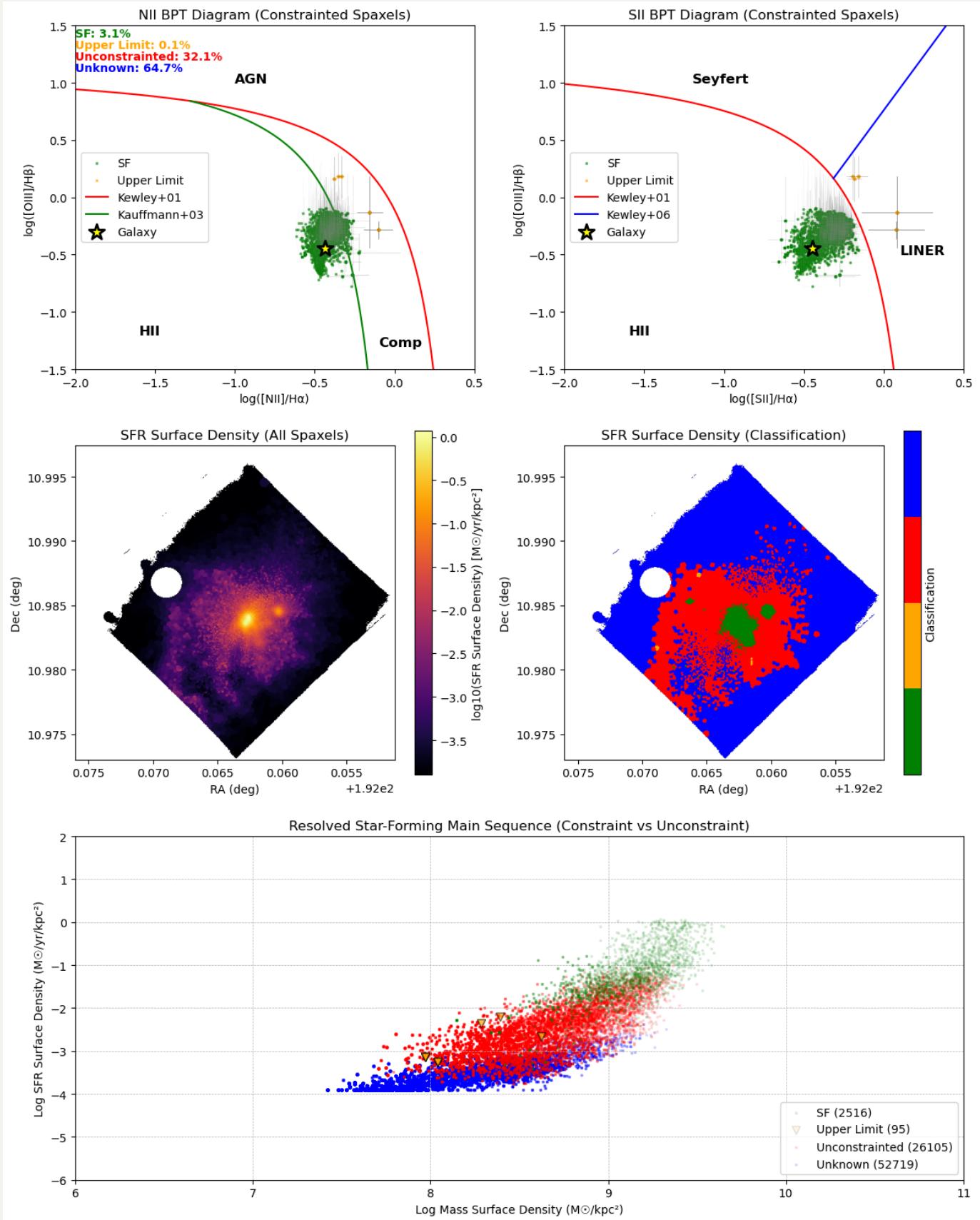
### 3.11 NGC4501



### 3.12 NGC4522



3.13 NGC4694



3.14 NGC4698

