FEEDBACK FROM MASSIVE STARS AT LOW METALLICITIES: MUSE OBSERVATIONS OF N44 AND N180 IN THE LARGE MAGELLANIC CLOUD

A.F. McLeod, J.E. Dale, C.J. Evans, et. al.

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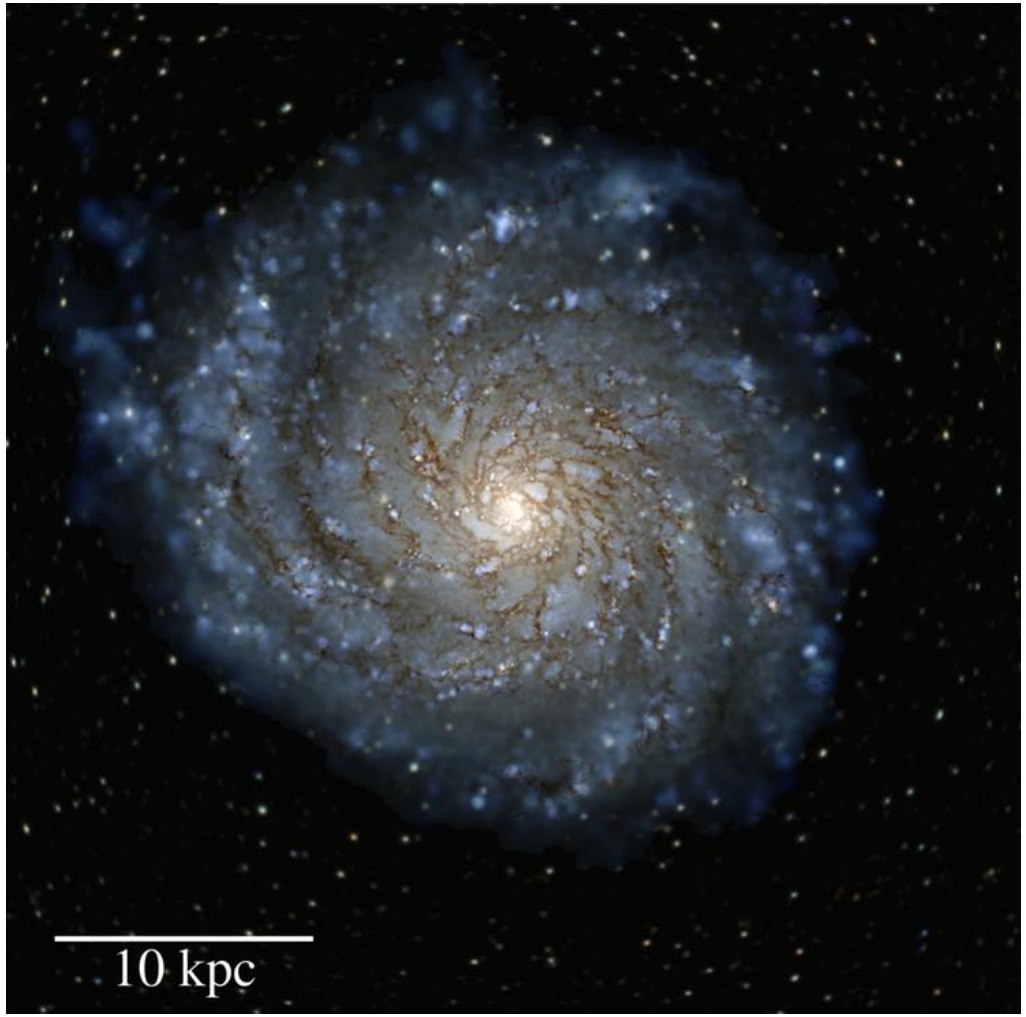
Grace Olivier

MOTIVATIONS & CONTEXT

Massive stars change their environment significantly.

- Outflows
- Winds
- Ionizing radiation
- Supernovae

Galaxy formation and evolution simulations have trouble recreating realistic galaxies.



Phil Hopkins' Research Group
Romeo (m12 ELVIS Local Group analogue)

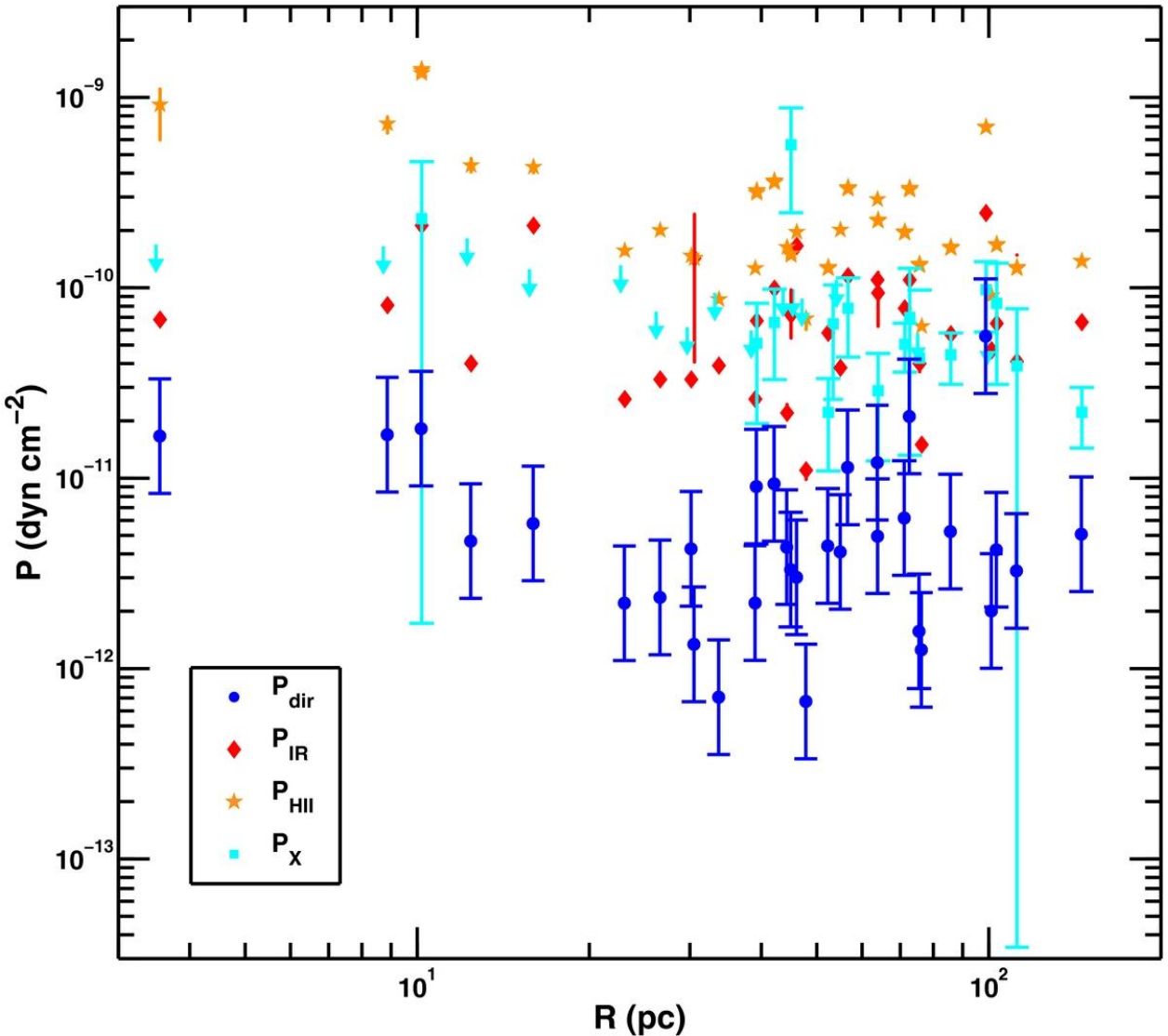
MOTIVATIONS & CONTEXT

Growing number of studies focusing on feedback in the last two decades.

- Lopez et al. 2011
- Lopez et al. 2014
- Many more

Feedback mechanisms:

- Direct radiation
- Dust-processed radiation
- Ionized gas
- Stellar winds



Lopez et al. 2014

MUSE – MULTI UNIT SPECTROSCOPIC EXPLORER

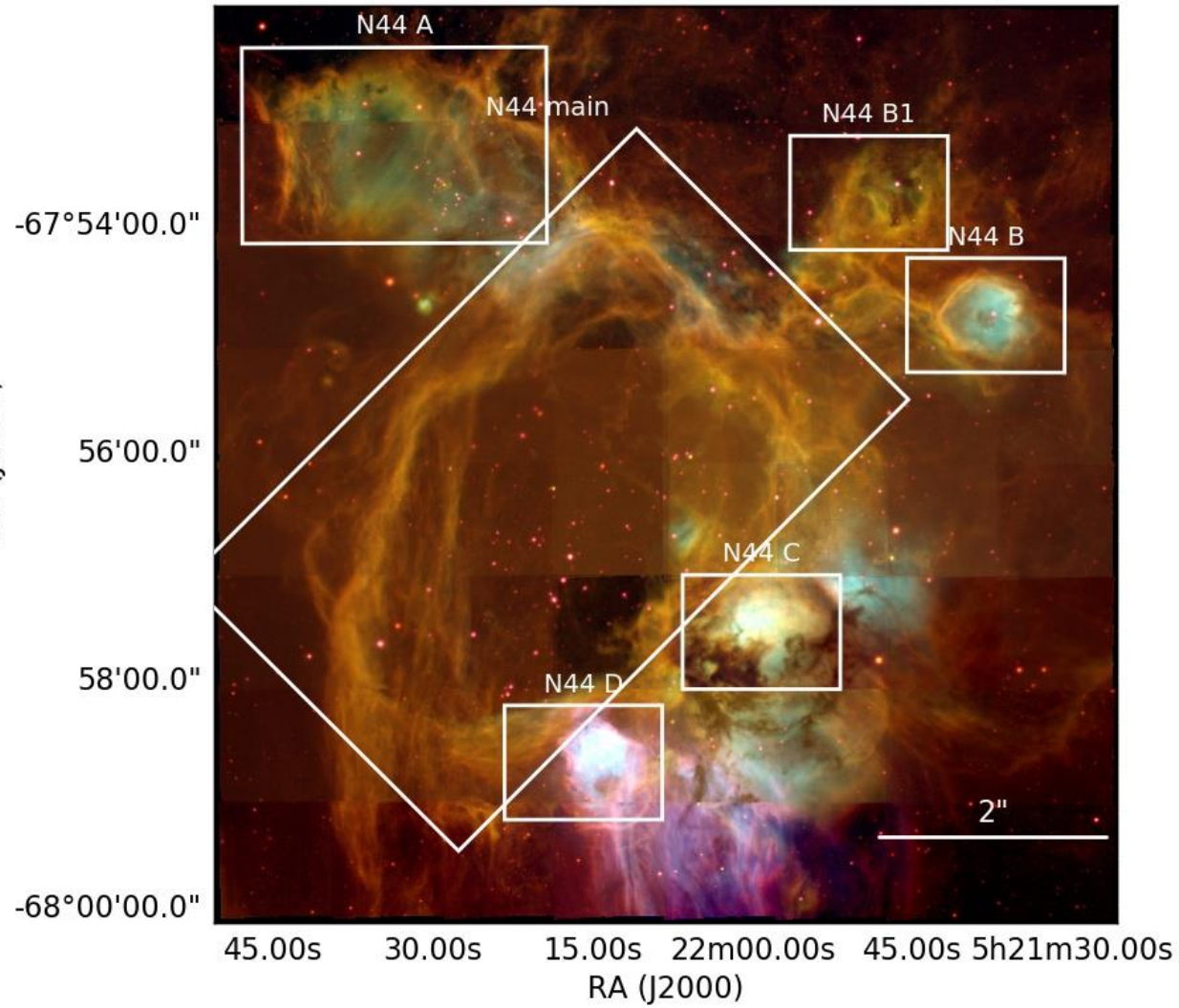
Mounted on the VLT

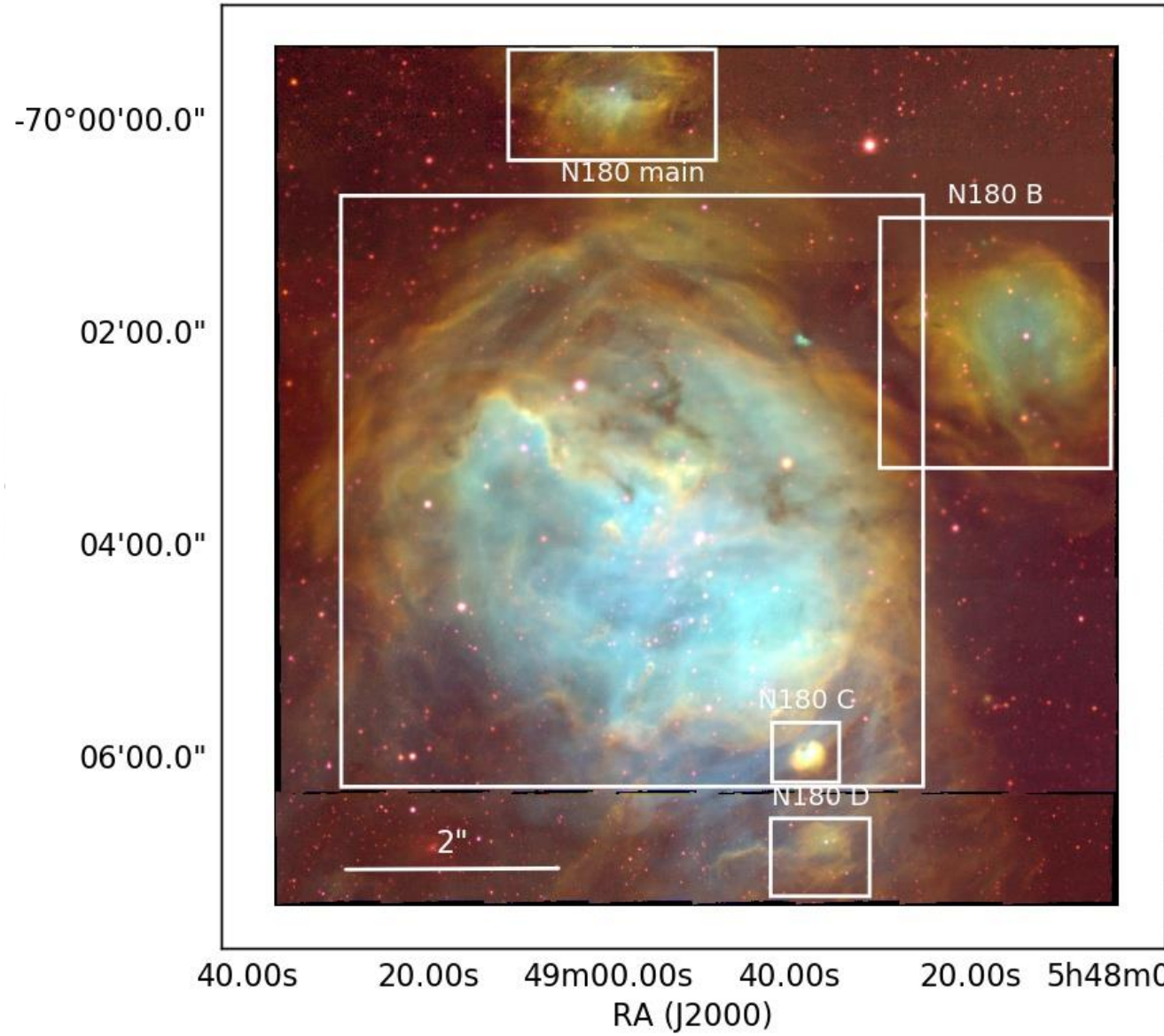
Pixel scale of 0.2 arcsec/pixel

Resolving power of 1770 to 3590 over range of 4750 A – 9350 A.

Credit:ESO/Y. Beletsky

N44 & N180


N44 A
N44 main
N44 B1
N44 B
N44 C
N44 D
2"
-67°54'00.0"
56'00.0"
58'00.0"
-68°00'00.0"
45.00s
30.00s
15.00s
22m00.00s
45.00s
5h21m30.00s
RA (J2000)

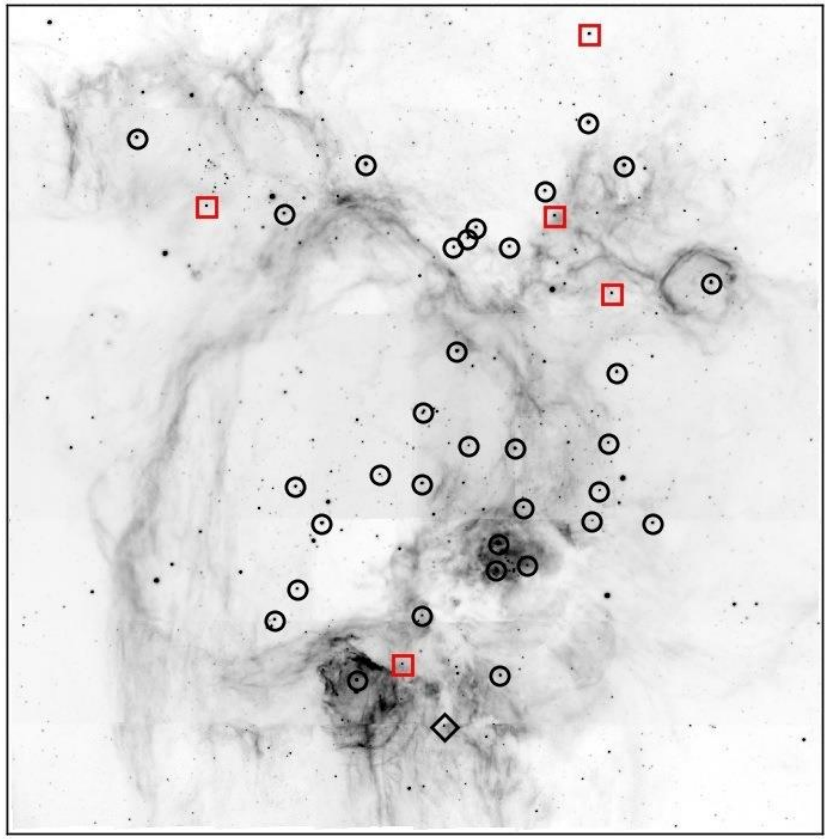

N180 main
N180 B
N180 C
N180 D
2"
-70°00'00.0"
02'00.0"
04'00.0"
06'00.0"
40.00s
20.00s
49m00.00s
40.00s
20.00s
5h48m0
RA (J2000)

O-STAR CENSUS

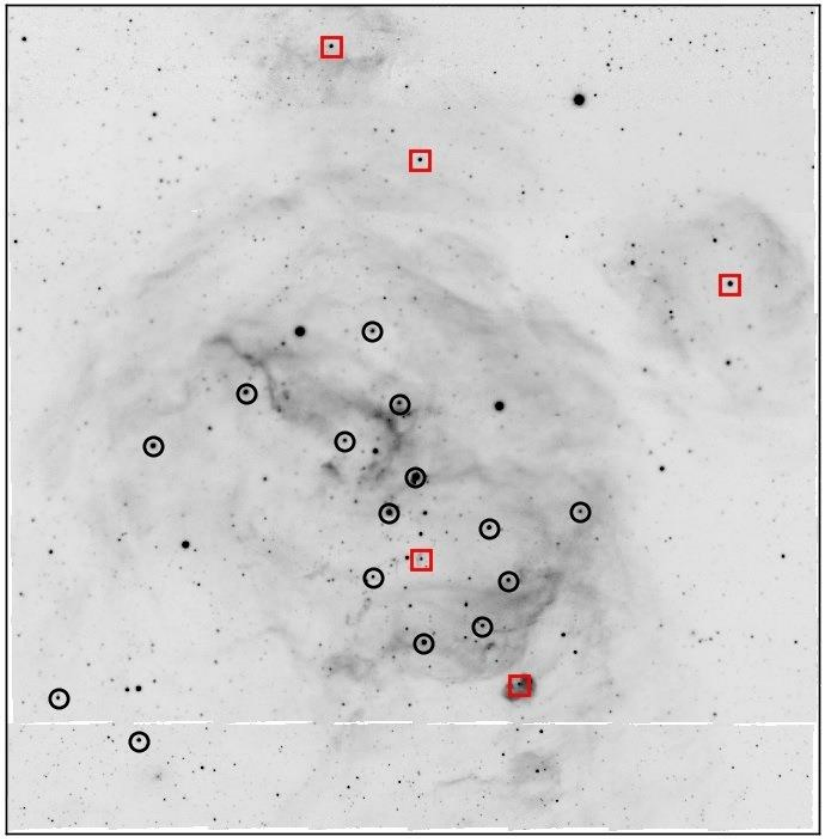
10 new O-stars

- 5 per region

Reclassified 1 previously identified O star as a B star for each region.



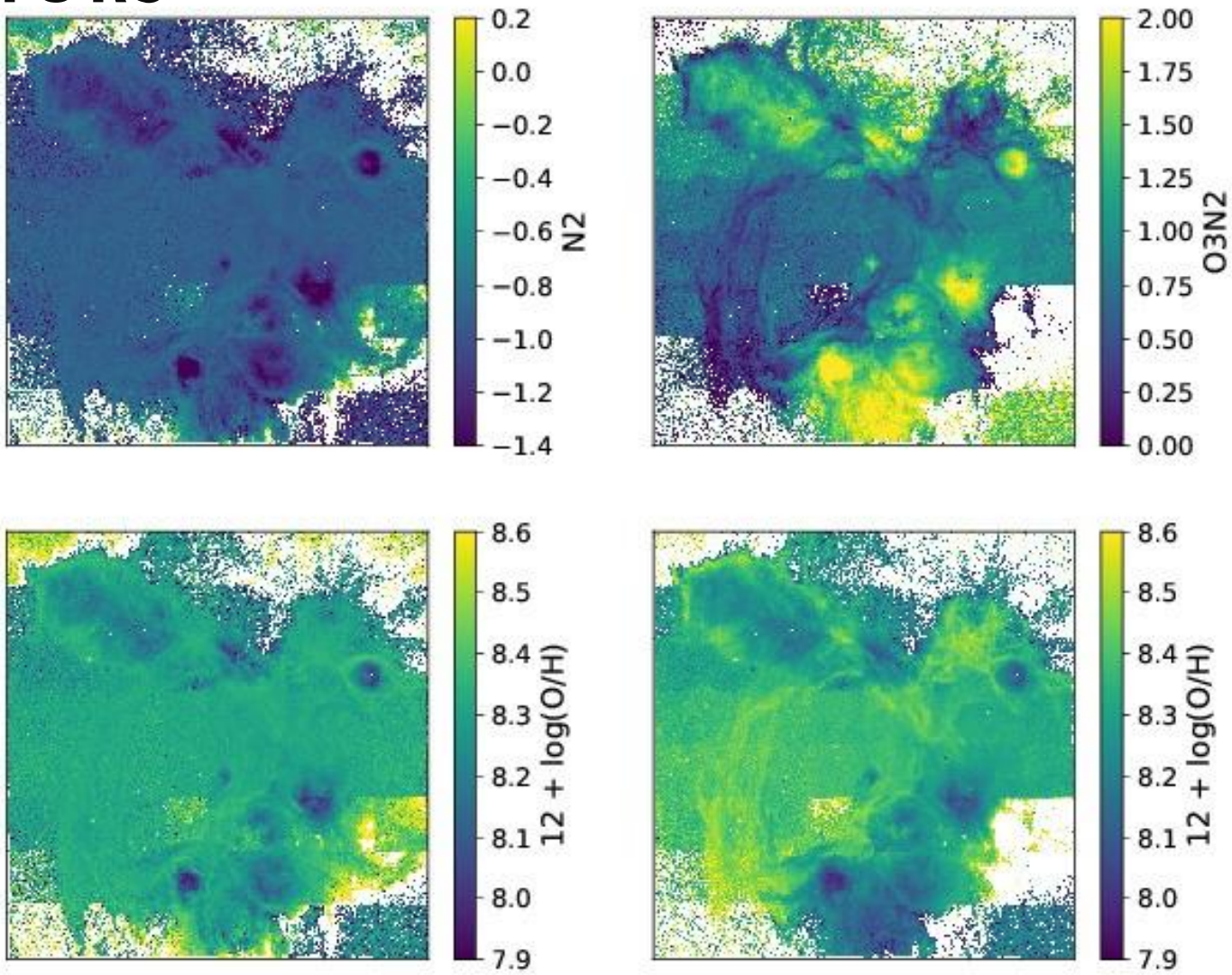
N44



N180

METALLICITY INDICATORS

Use strong-line method to calculate the oxygen abundances.



N44

FEEDBACK PRESSURES

Direct radiation pressure

Ionized gas pressure

Stellar wind pressure

No dust-processed radiation pressure

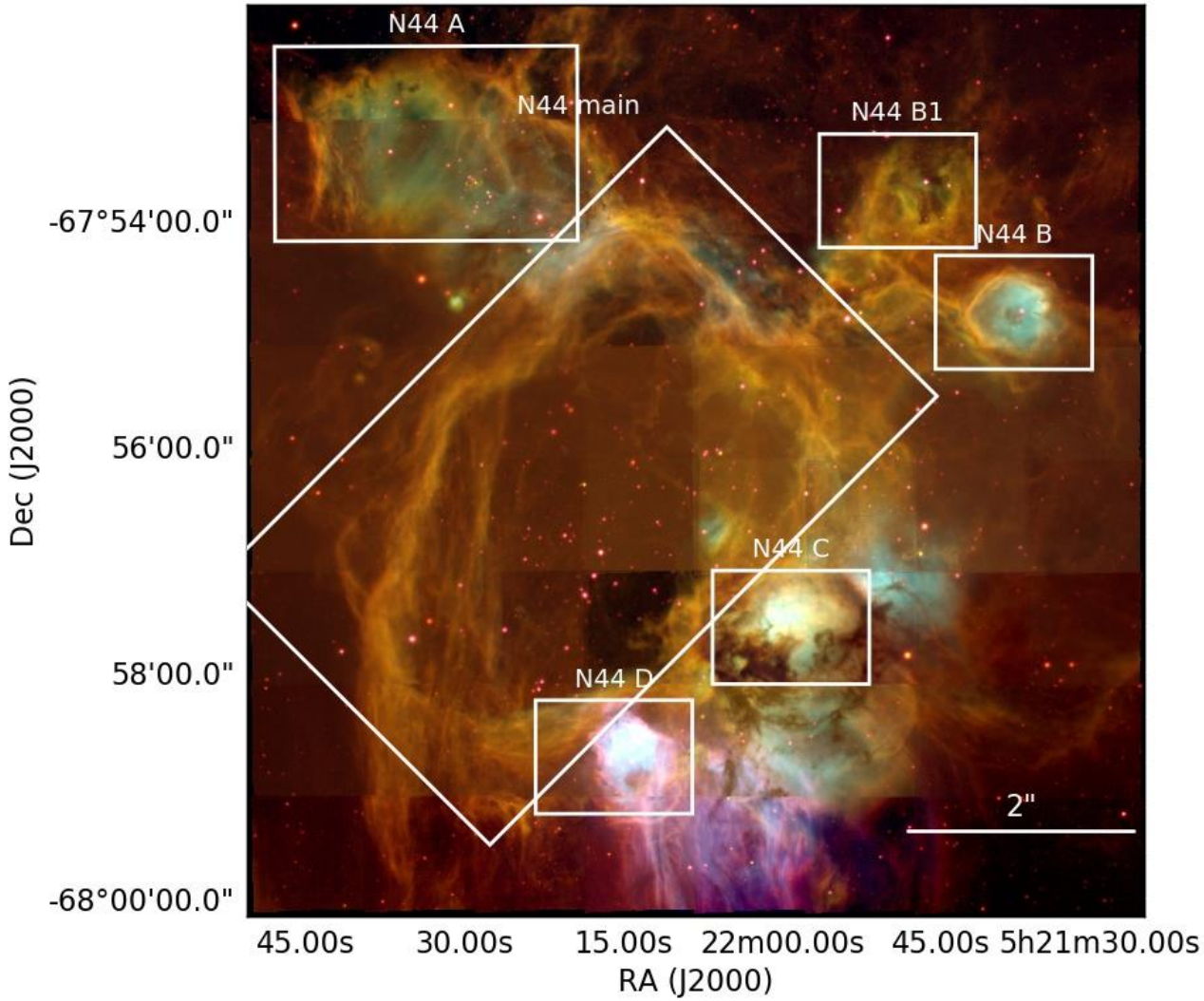
- They have no IR data

DIRECT RADIATION PRESSURE

Radiation pressure force integrated at the ionization front.

$$P_{dir} = \frac{Q_{0,*}\langle h\nu \rangle}{4\pi R^2 c}$$

- Here they assume $\langle h\nu \rangle = 15\text{eV}$

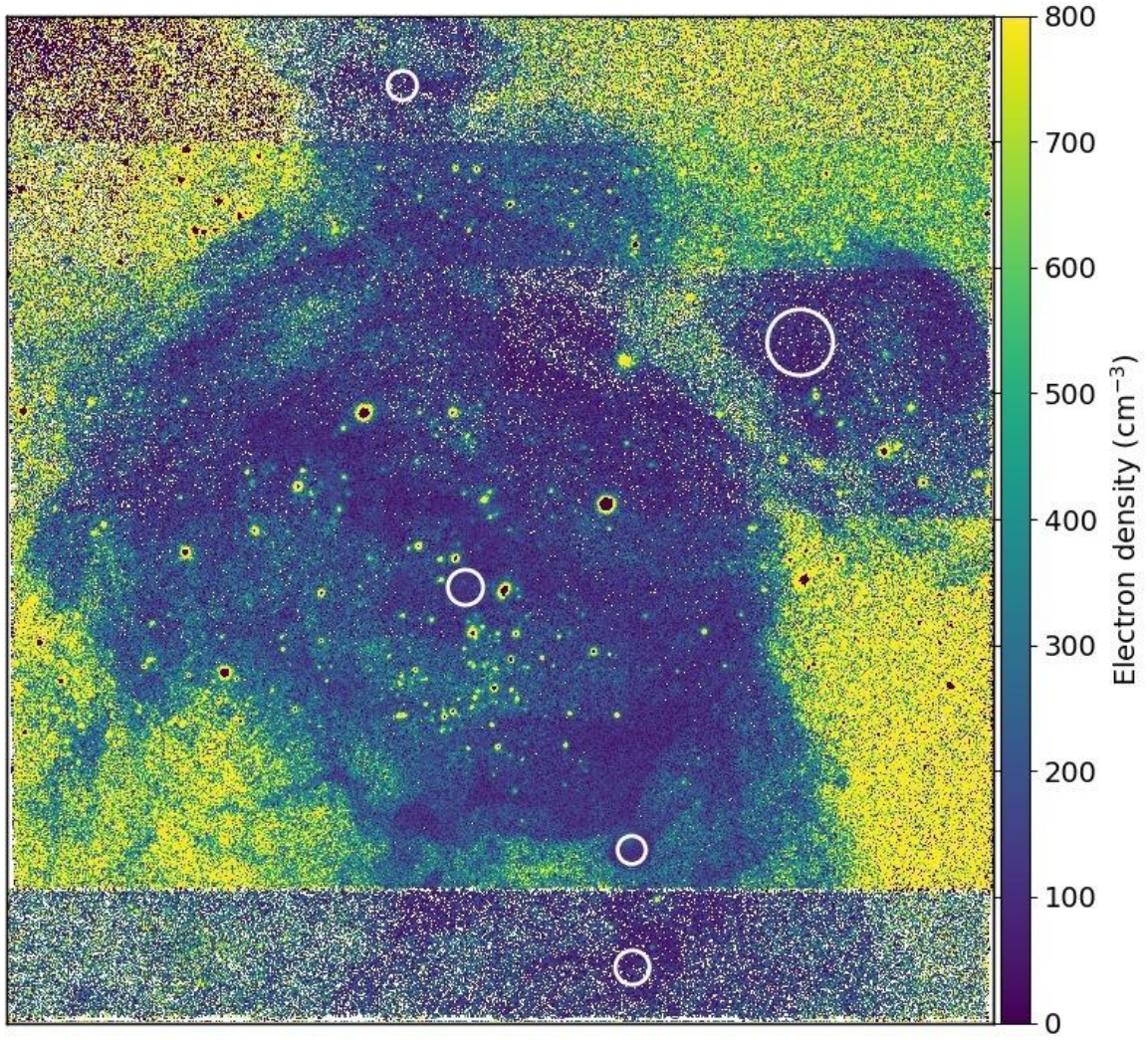


N44

IONIZED GAS PRESSURE

Pressure of an ideal gas at 10^4 K.

$$P_{ion} = (n_e + n_H + n_{He})kT_e$$
$$= 2n_e kT_e$$



N180

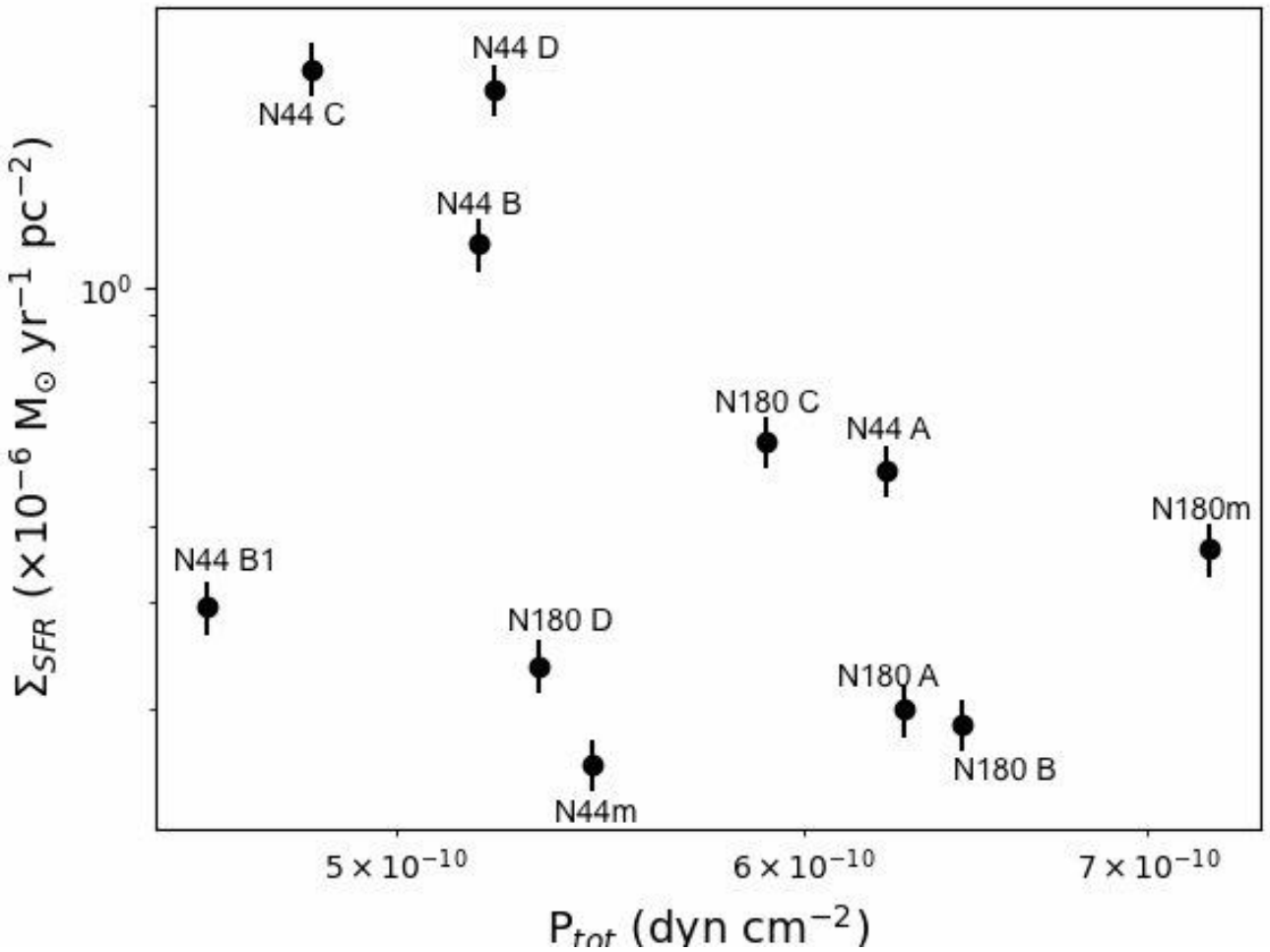
STELLAR WIND PRESSURE

2 methods:

- Measure pressure from radius according to wind driven bubbles, L_W
- Measure pressure from the wind luminosities of the stars driving the regions
  - $L_{W,*} = \frac{1}{2} M v_\infty^2$

STAR FORMATION RATE

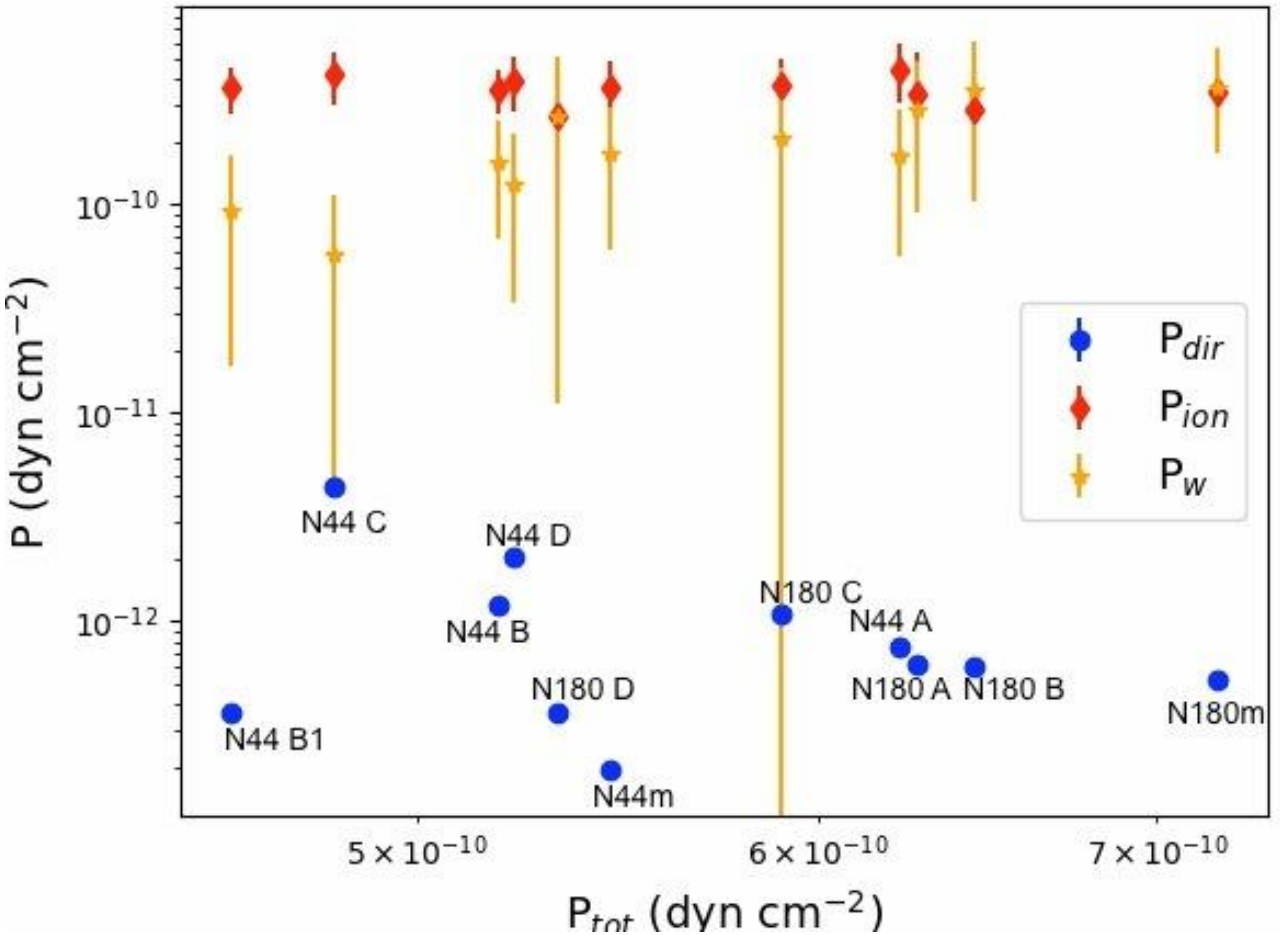
Use the Kennicutt (1998) relation to calculate the SFR for each region.



WHAT'S DRIVING THE DYNAMICS?

They find that ionized gas pressures generally drive the regions.

Direct radiation pressure is small.



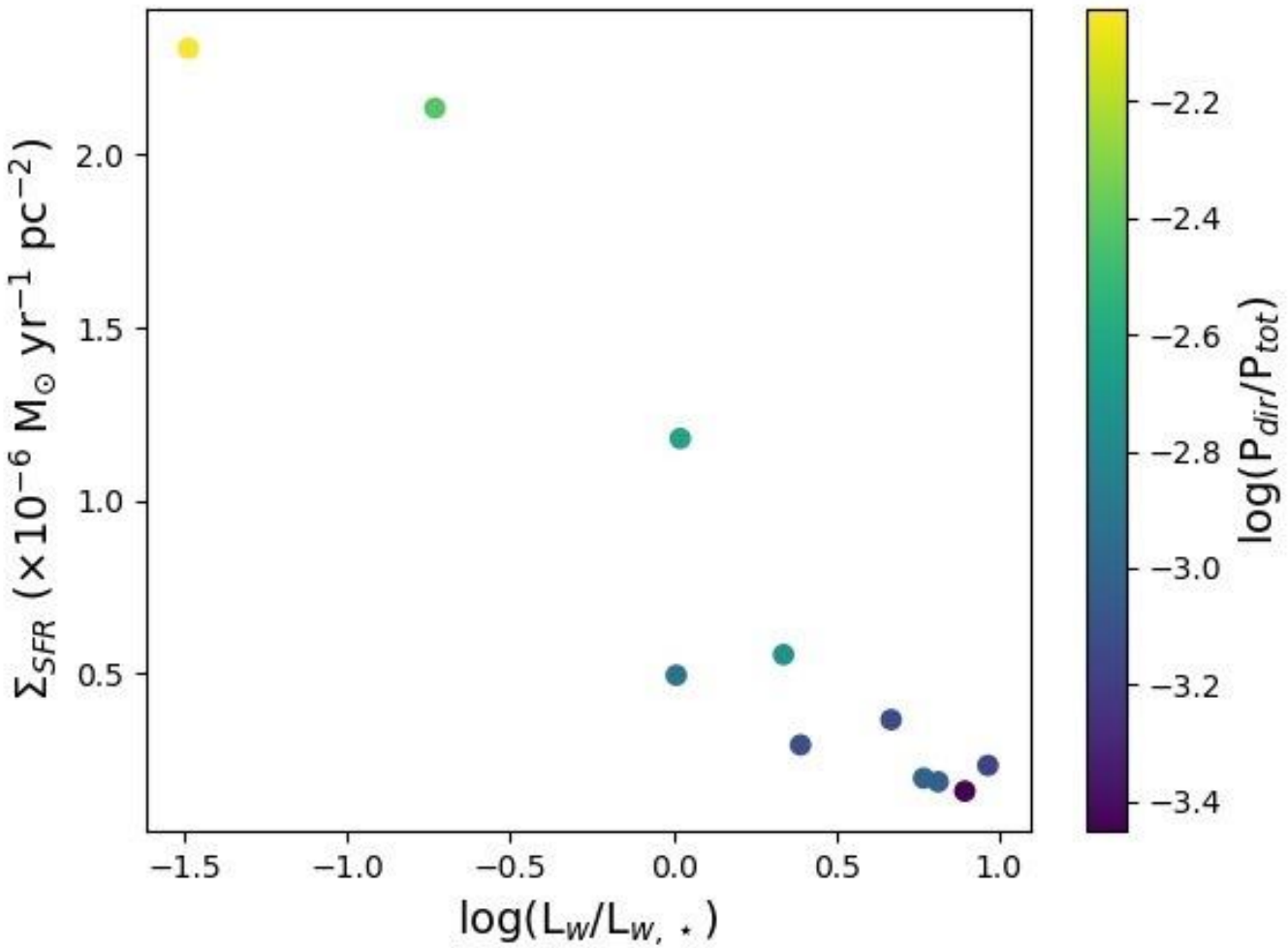
WIND COMPARISON

They compare the wind luminosities for each region.

$L_W > L_{W,*}$: other processes are driving the region.

$L_W \sim L_{W,*}$: winds are powering these regions.

$L_W < L_{W,*}$: these regions are too small for their stellar populations.



THEIR CONCLUSIONS

Feedback sets an upper limit for SFR.

Ionization pressure “generally dominates” these regions.

Some of the regions are too small compared to the radius they should have from their winds – expanding into dense material.

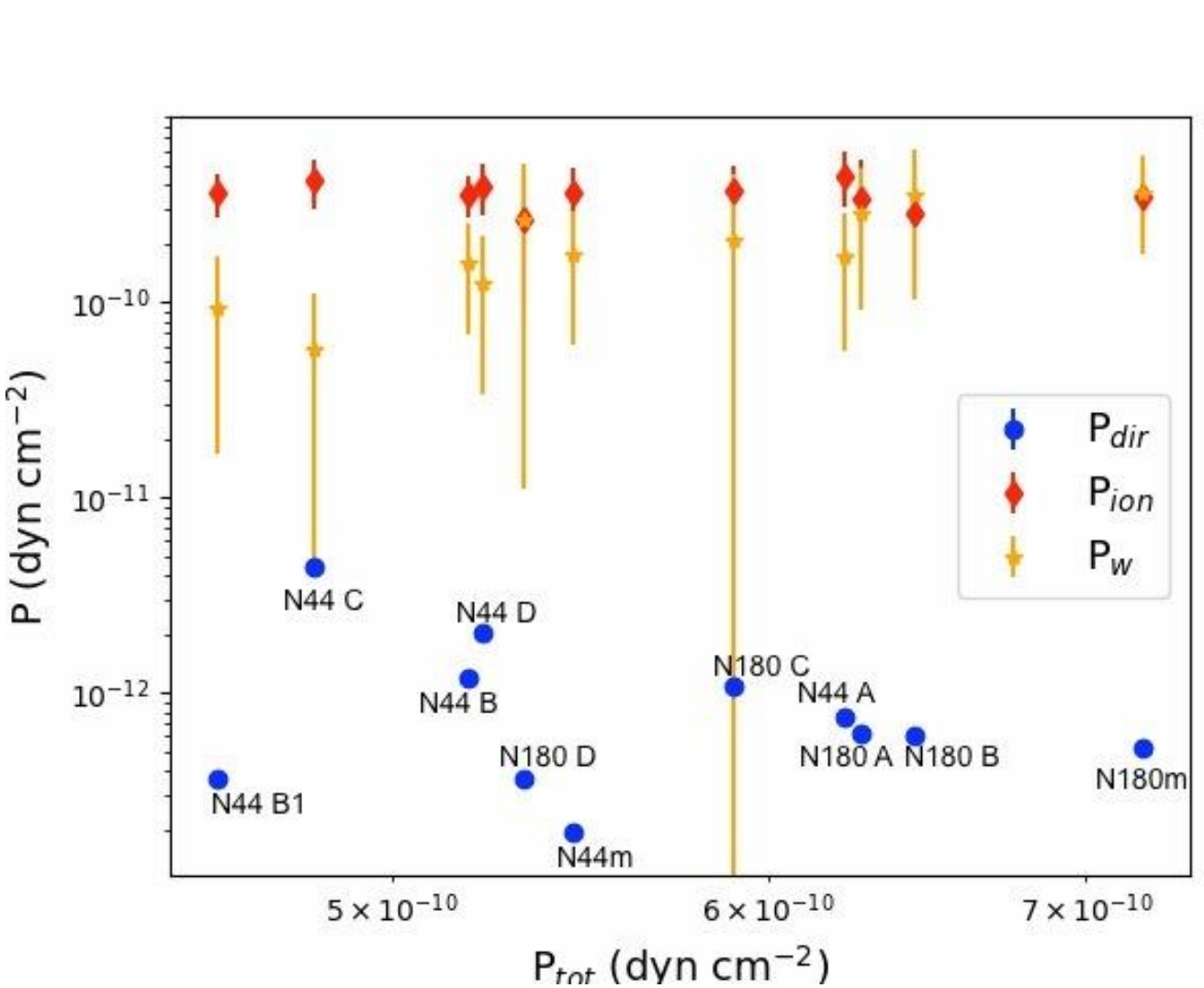
MY CONCERNS

SFR – Kennicutt (1998) assumes a population of HII regions of different ages…

Direct radiation pressure makes assumptions about the gas that's being pushed.

Wind luminosities – contradict their pressure calculations.

No mention of X-rays.



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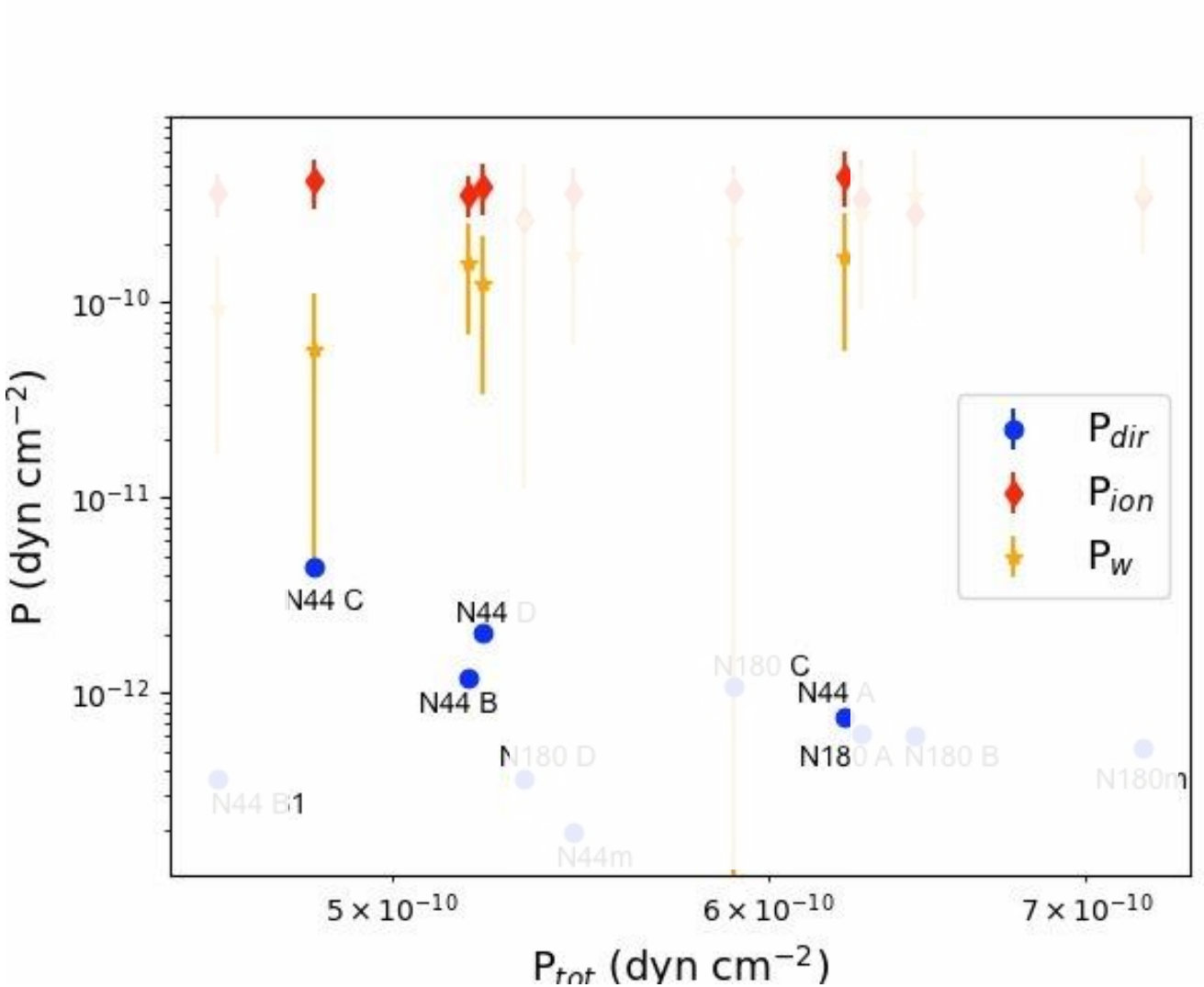

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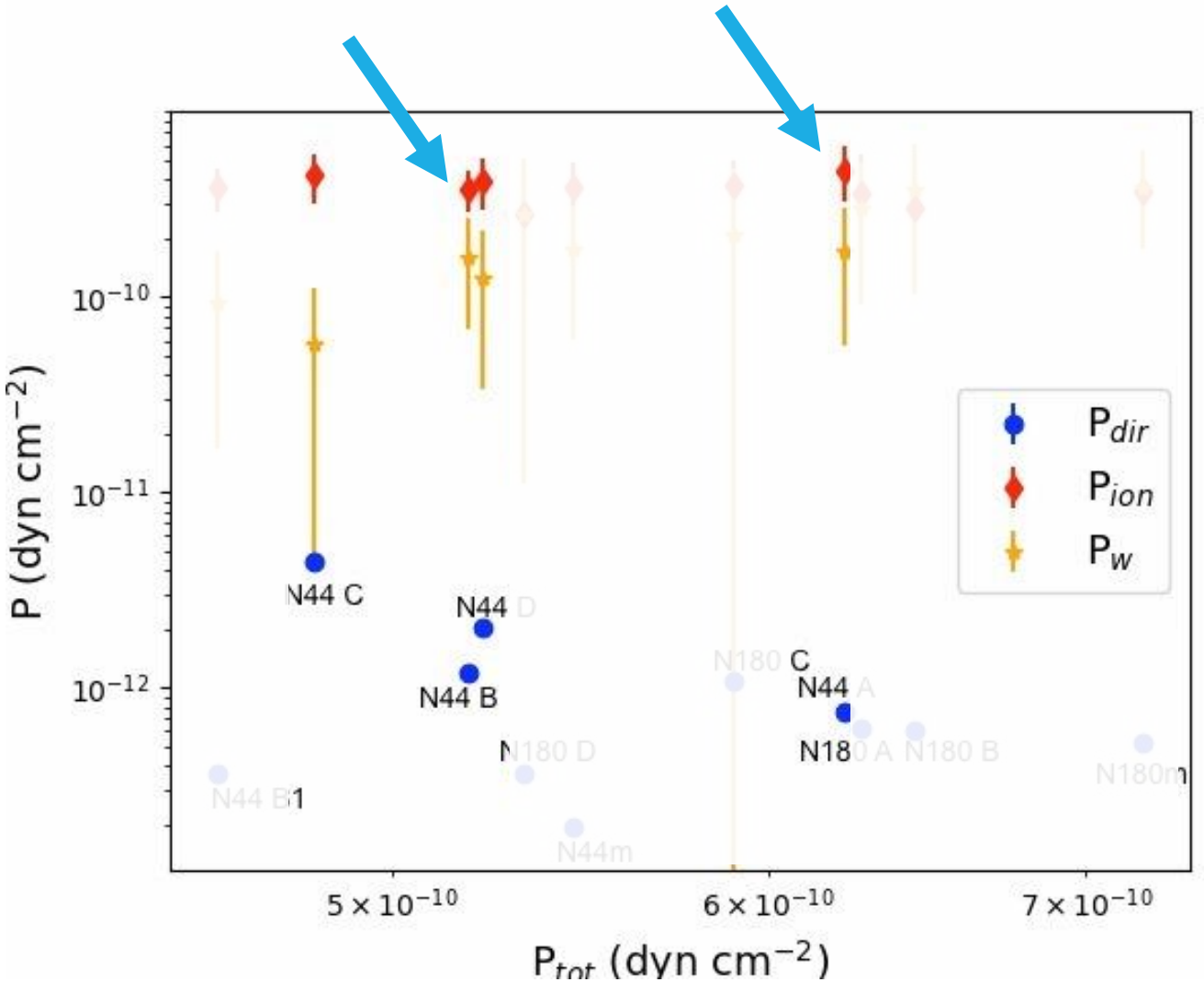

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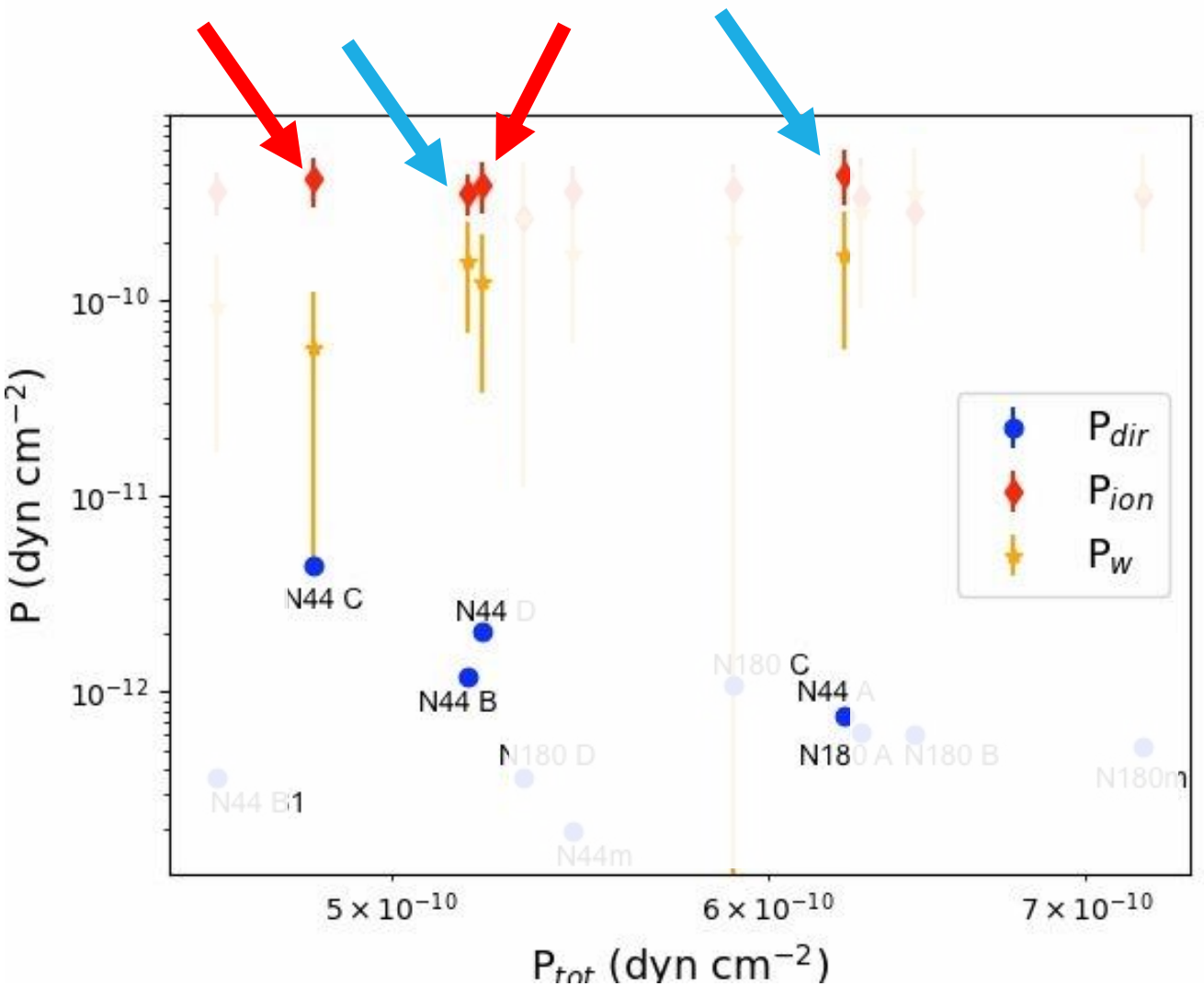

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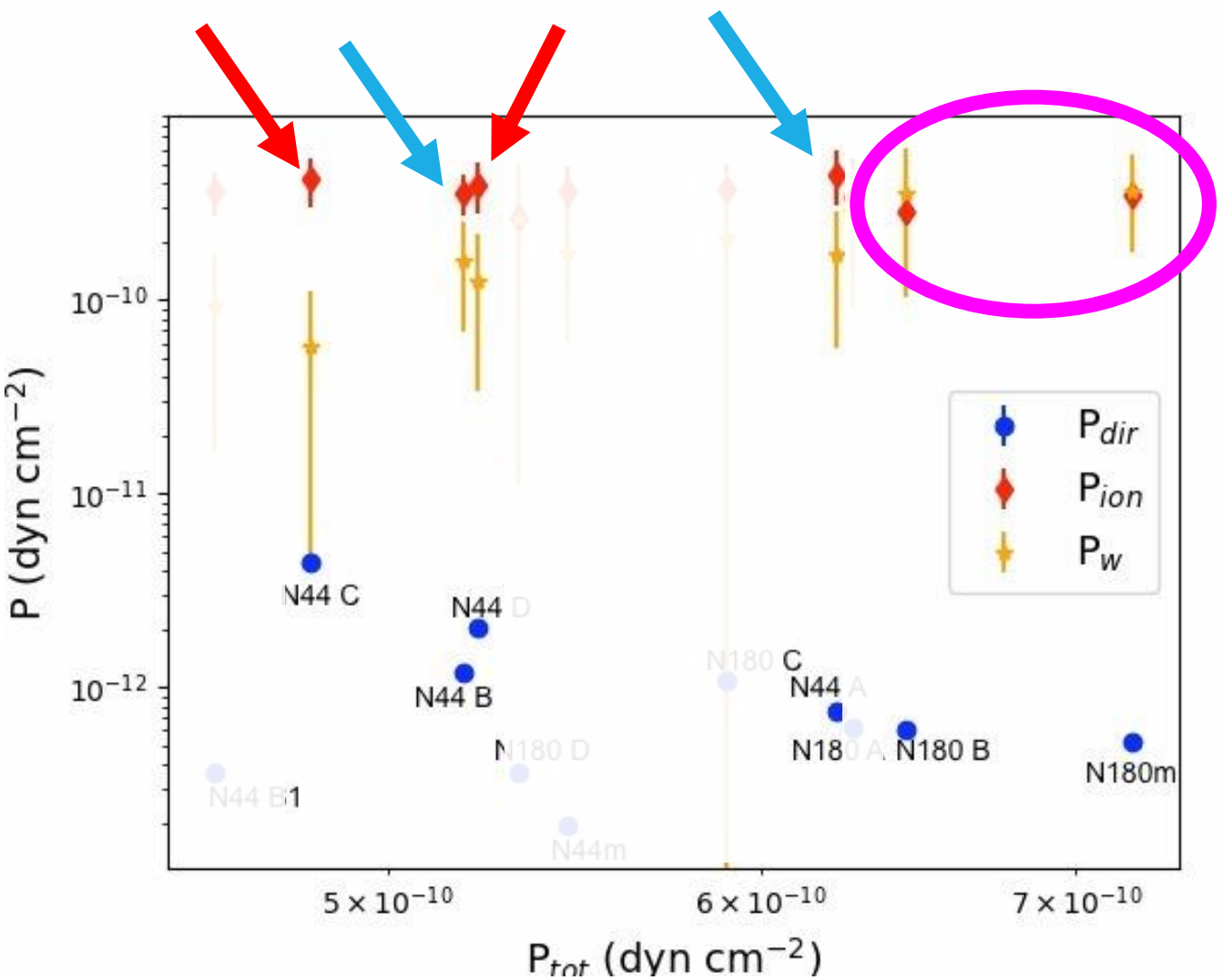
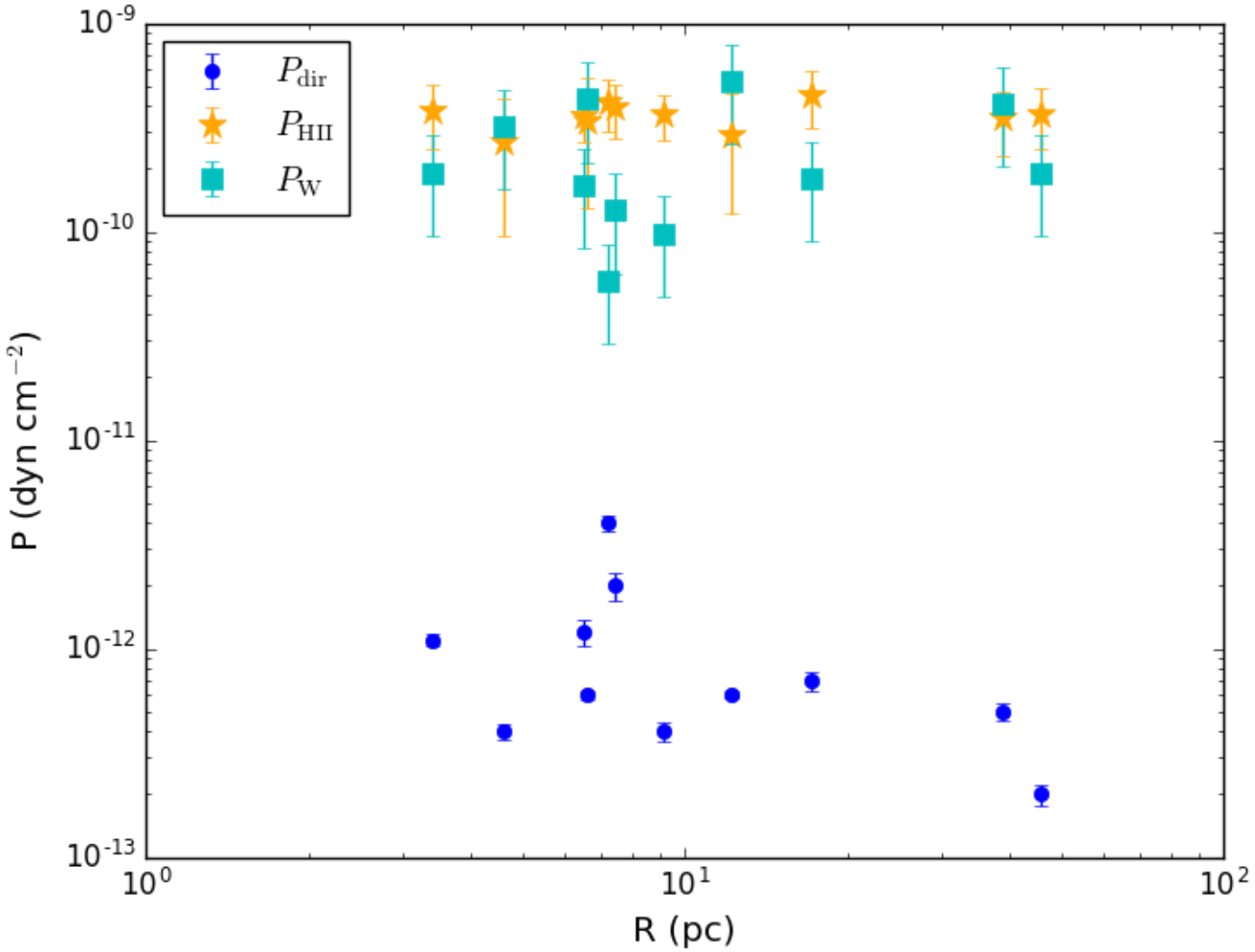


MY CONCLUSIONS

If we plot these regions as P vs R we can put them in context with other measurements.



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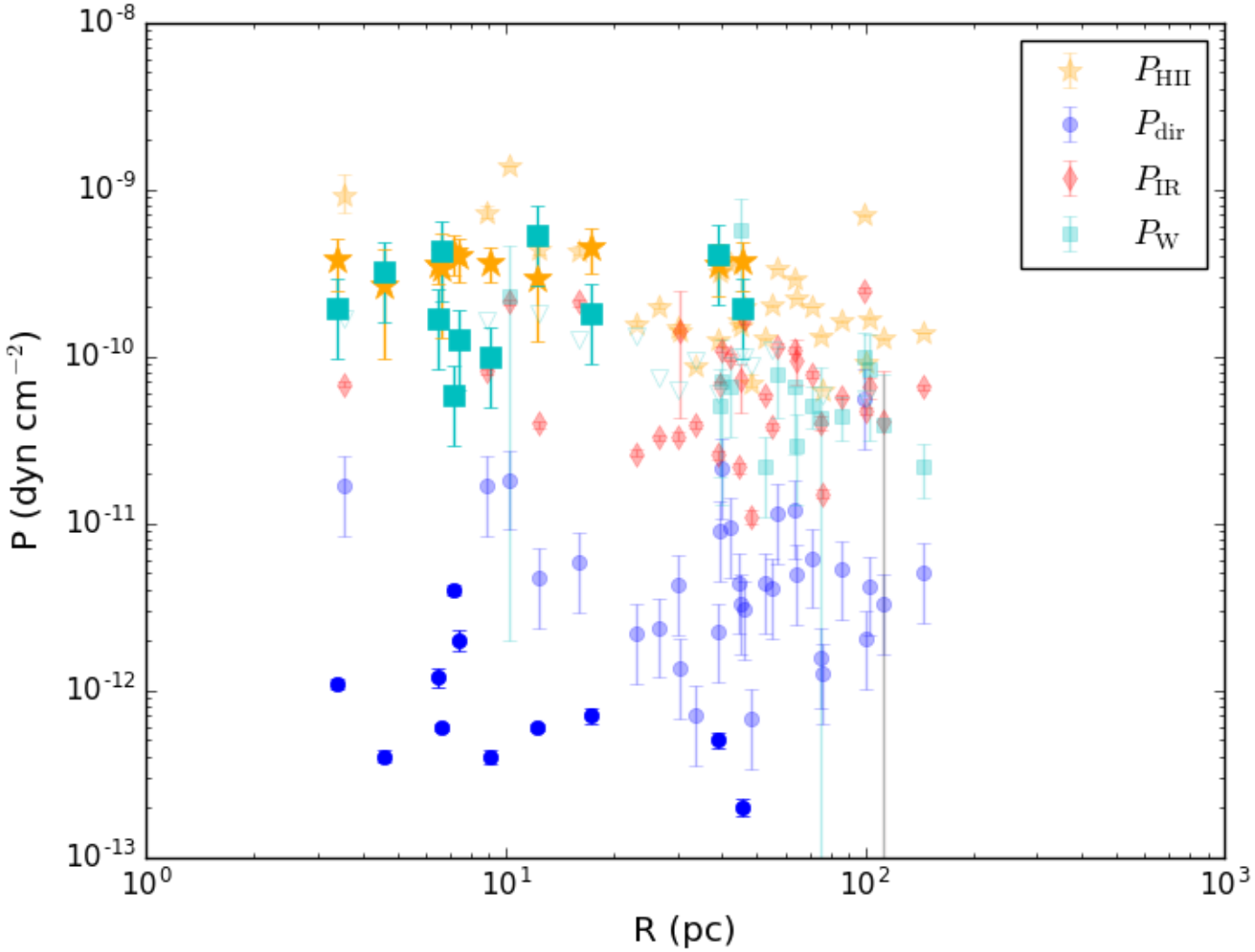

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Generally, the new measurements of feedback pressures agree with previous and in progress work.