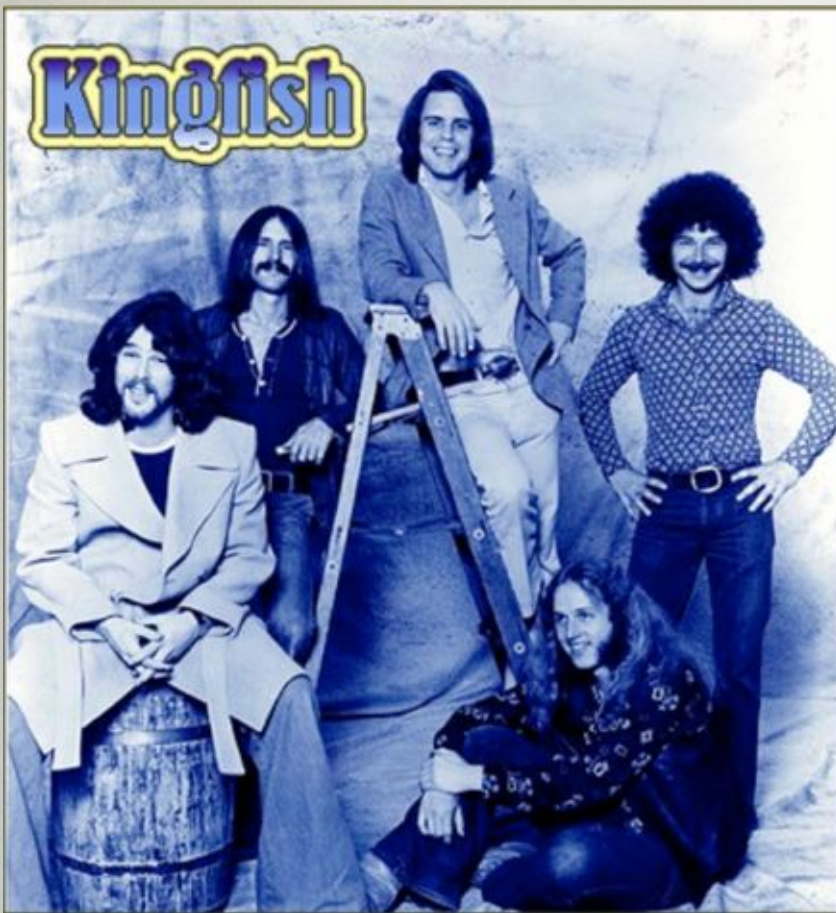


OXYGEN IN THE FAR-IR

MAPPING NEARBY GALAXIES WITH HERSCHEL

KEVIN CROXALL
AND THE KINGFISH TEAM





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- Pedro Beirao
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- Karl Gordon
- David Green
- **Brent Groves**
- Caina Hao
- George Helou
- Rodrigo Herrera Camus
- Joannah Hinz
- Leslie Hunt
- **Ben Johnson**
- Jin Koda
- Oliver Krause
- **Kathryn Kreckel**
- Adam Leroy
- Yiming Li
- Sharon Meidt
- Edward Montiel
- Eric Murphy
- Nurur Rahman
- John Richer
- Hans-Walter Rix
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- Marc Sauvage
- Eva Schinnerer
- Ramin Skibba
- **J.D. Smith**
- Sundar Srinivasan
- Laurent Vigroux
- Fabian Walter
- Bradley Warren
- Christine Wilson
- Mark Wolfire
- Stefano Zibetti



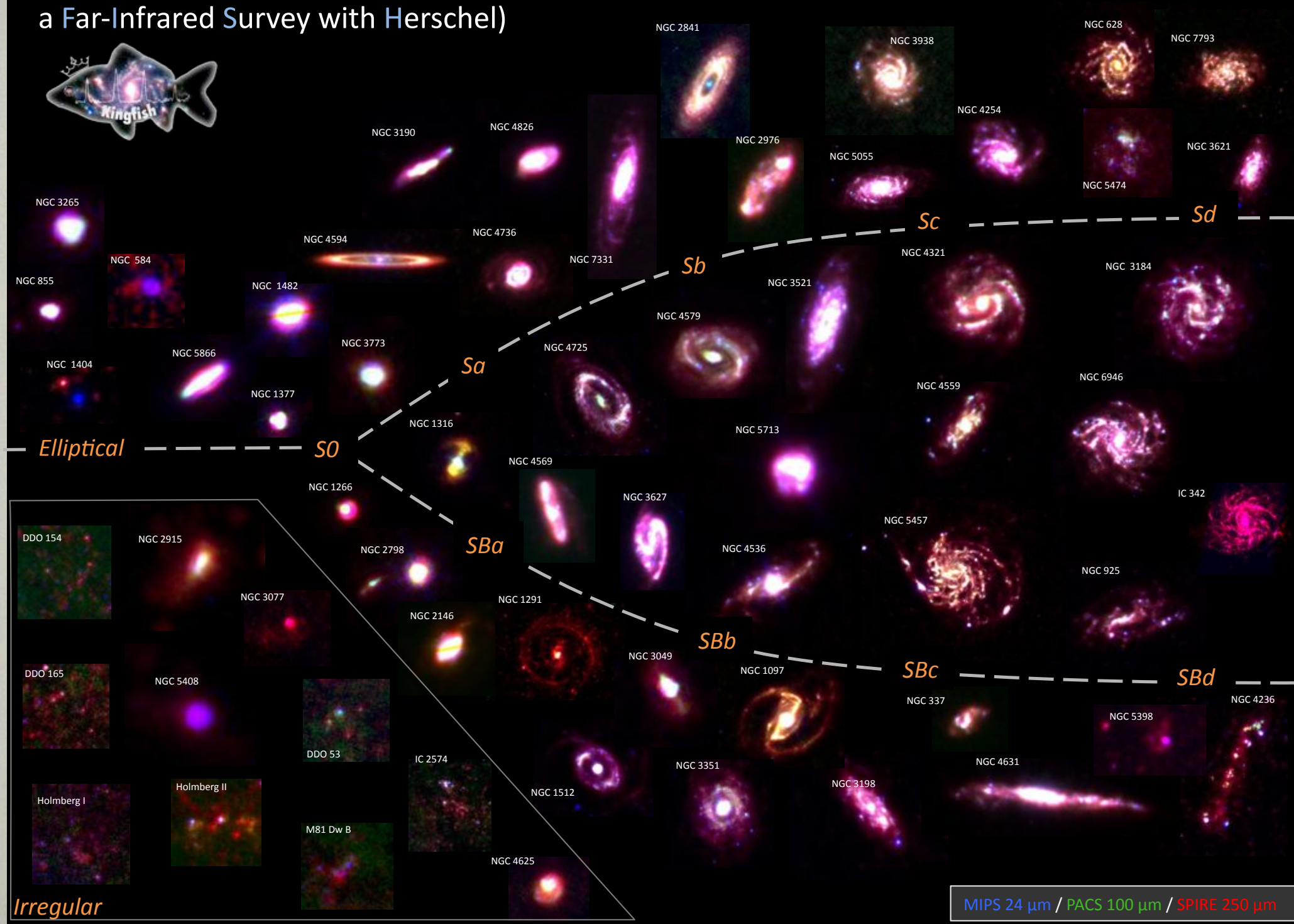
KEY INSIGHTS ON NEARBY GALAXIES: A FAR-INFRARED SURVEY WITH HERSCHEL



- STAR-FORMATION RATE TRACERS
- STAR-FORMATION (SCHMIDT) LAW(S)
- GAS+DUST: COUPLED ENERGY BUDGET OF HEATING AND COOLING (SF & WEAK AGN)
- ISM CONDITIONS, RADIO/IR CORRELATION
- (TEMPERATURE INSENSITIVE) ABUNDANCES
- DUST MASS BUDGET (COLD DUST DISTRIBUTION?)
- RESOLVING OUT THE RADIO-IR CORRELATION

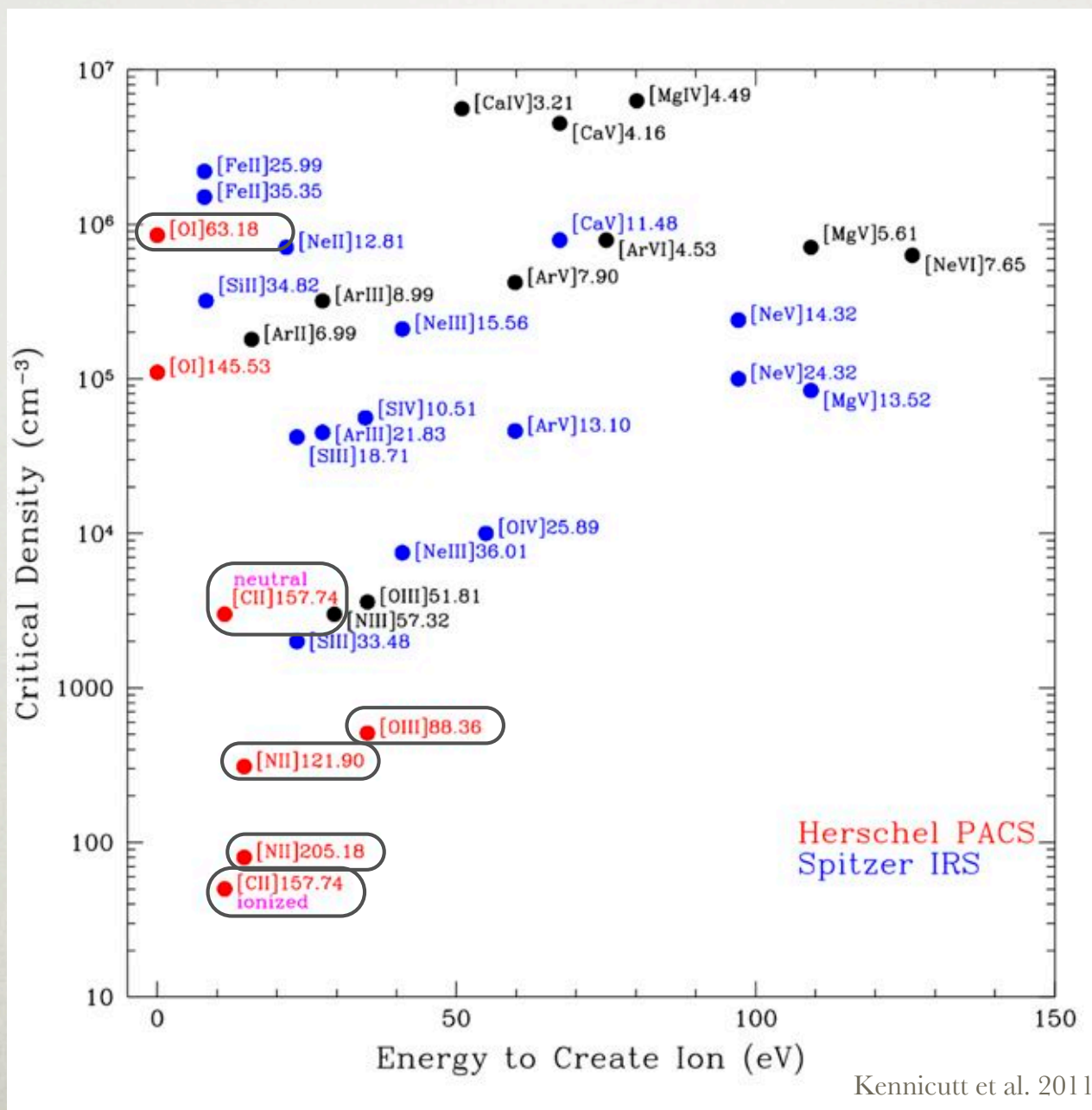


Kingfish (Key Insights on Nearby Galaxies: a Far-Infrared Survey with Herschel)





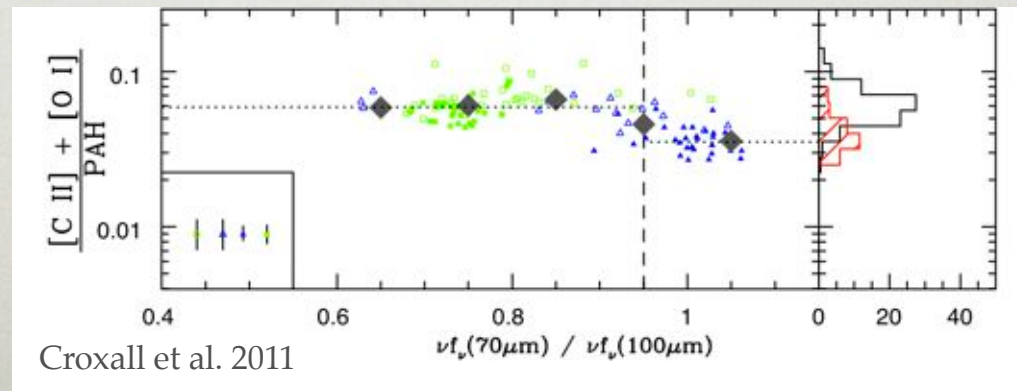
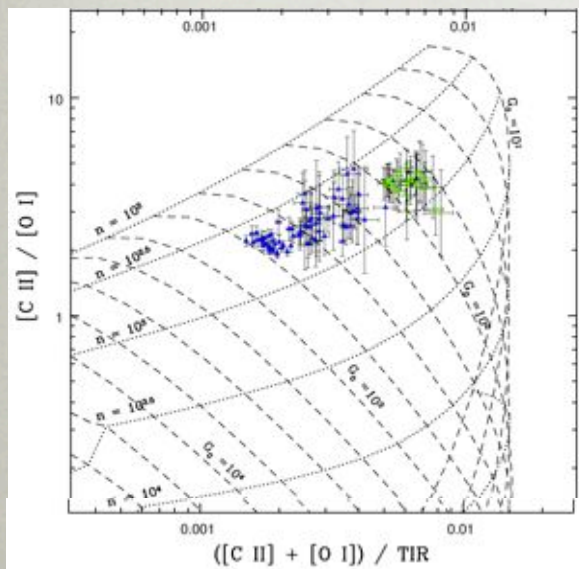
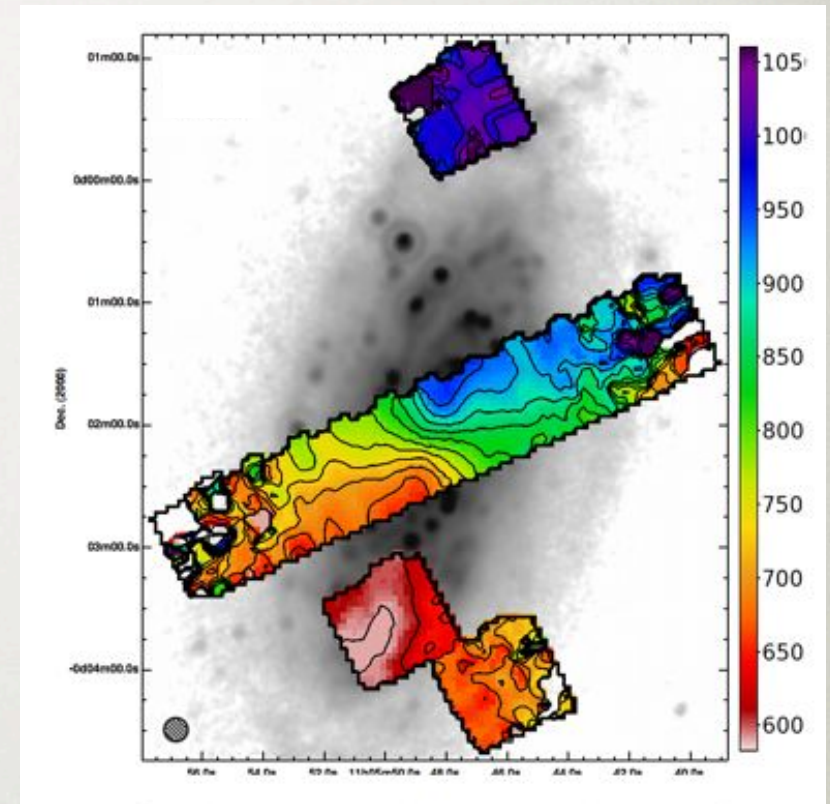
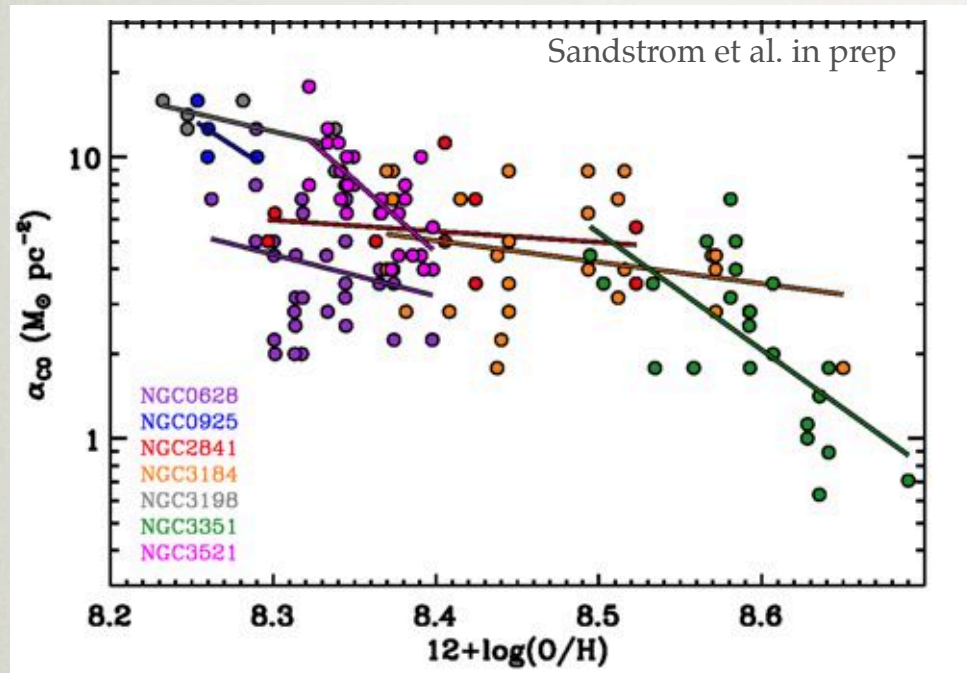
A SAMPLING OF LINES



Kennicutt et al. 2011



INVESTIGATING DUST PROPERTIES

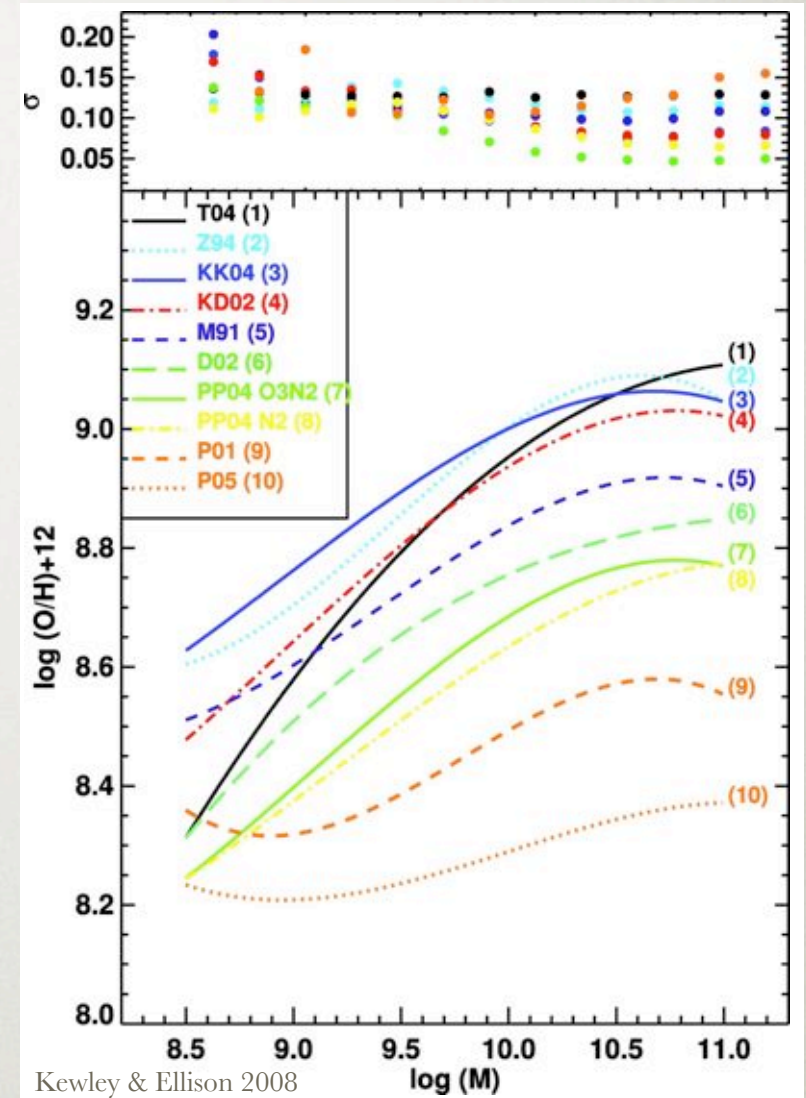
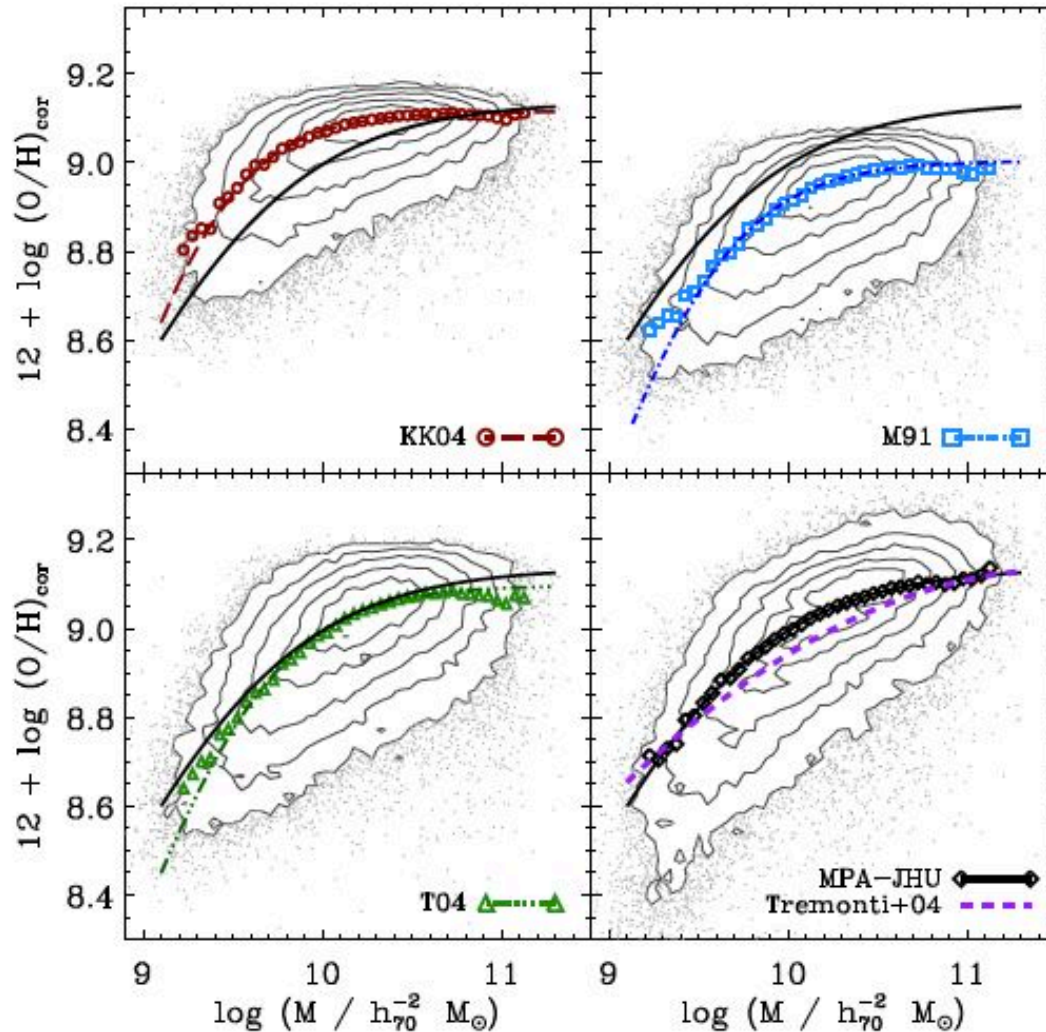


Croxall et al. 2011



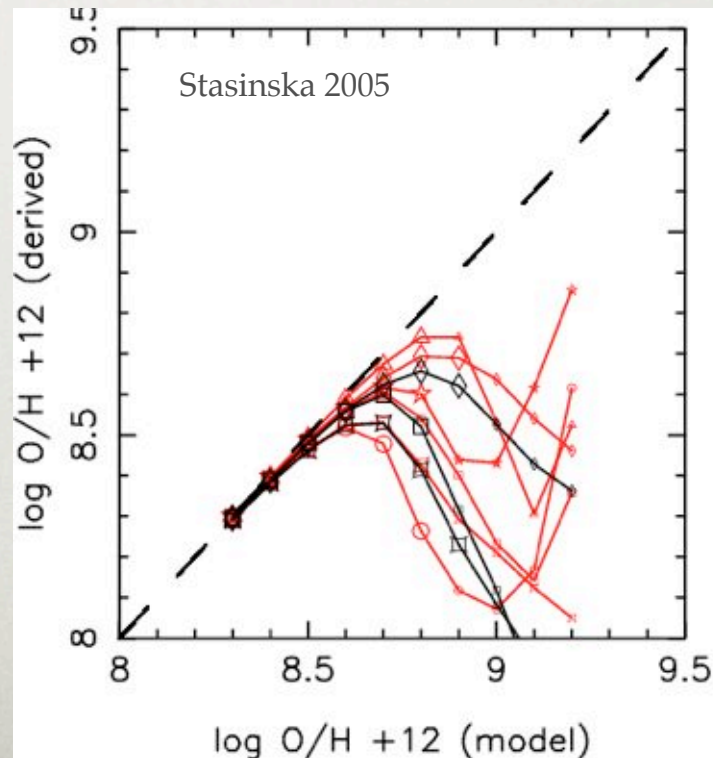
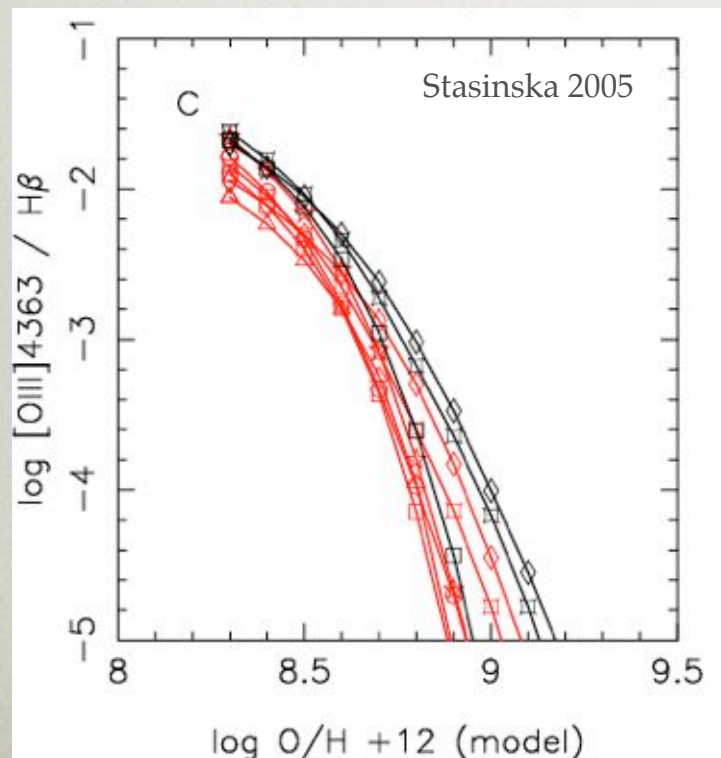
DEX IS A LOGARITHMIC UNIT

Moustakas et al. 2012

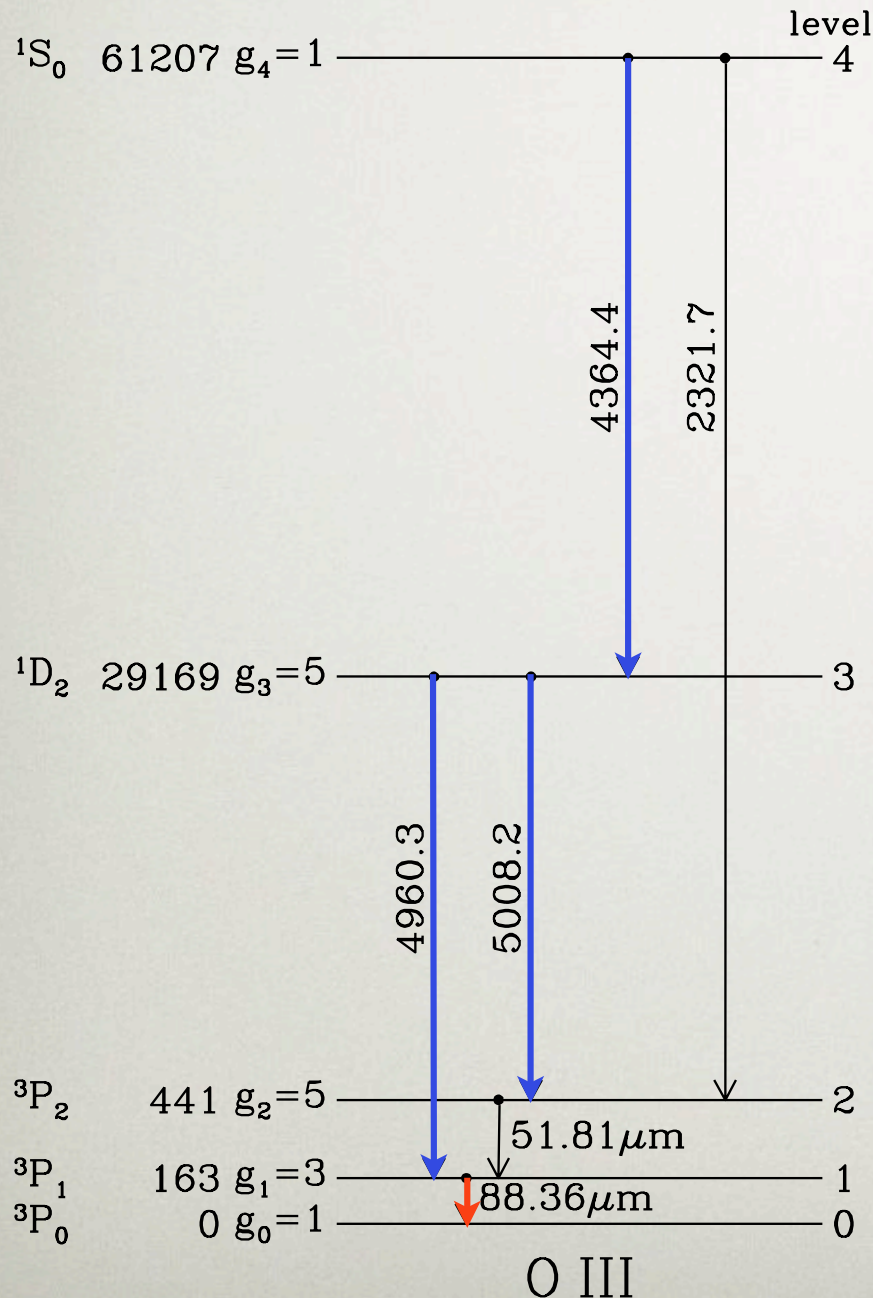


THE TEMPERATURE OF AN HII REGION

- At high O/H we lose ability to detect the temperature sensitive [O III] 4363 line.
- Different spectral lines yield different temperatures.
- Temperatures are not uniform within an HII region.



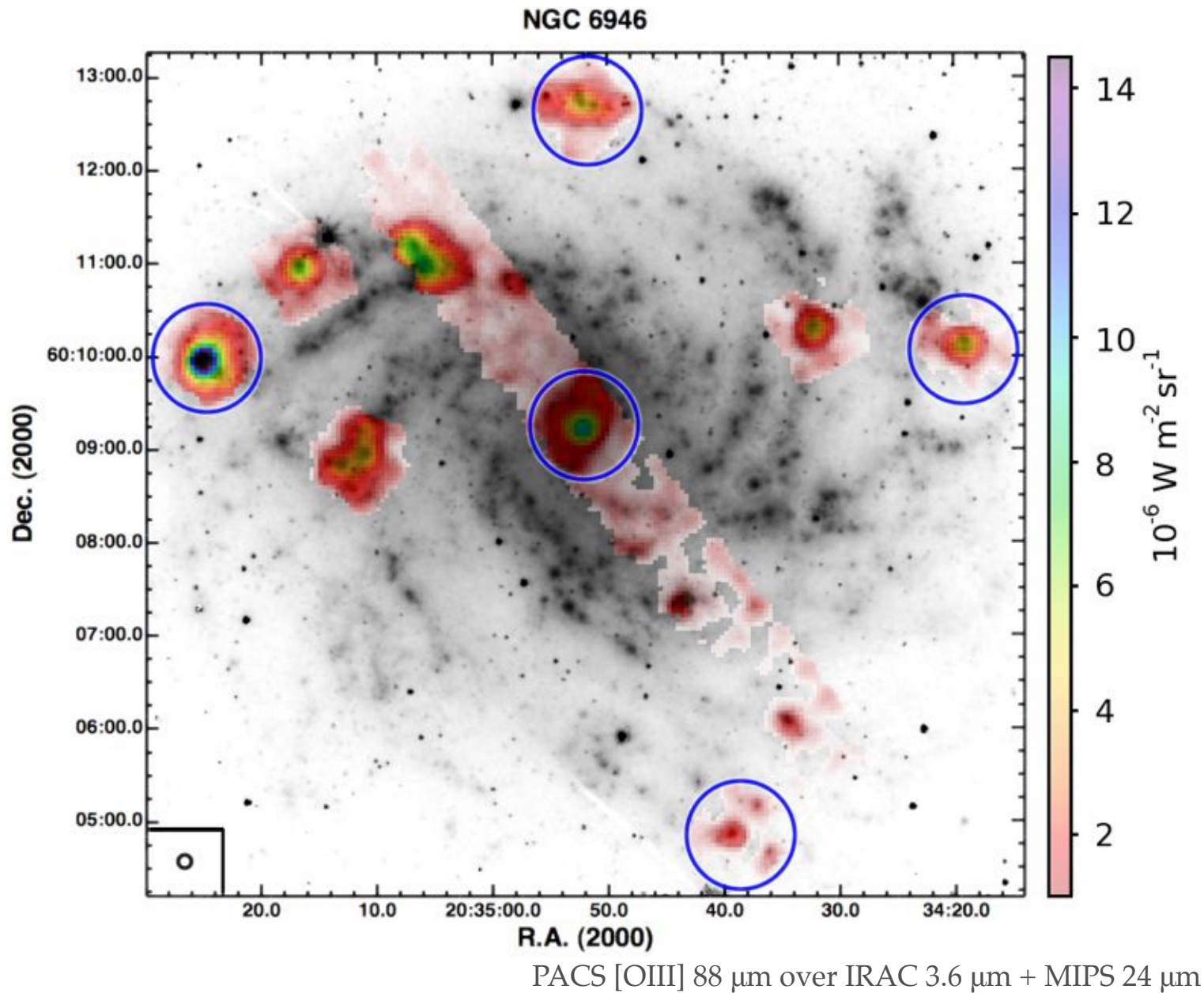
YOU ALWAYS GET [OIII] 88 μ M



- Temperature Sensitivities
- Density Dependencies
- Ionization Correction Factors
- Dust Obscuration



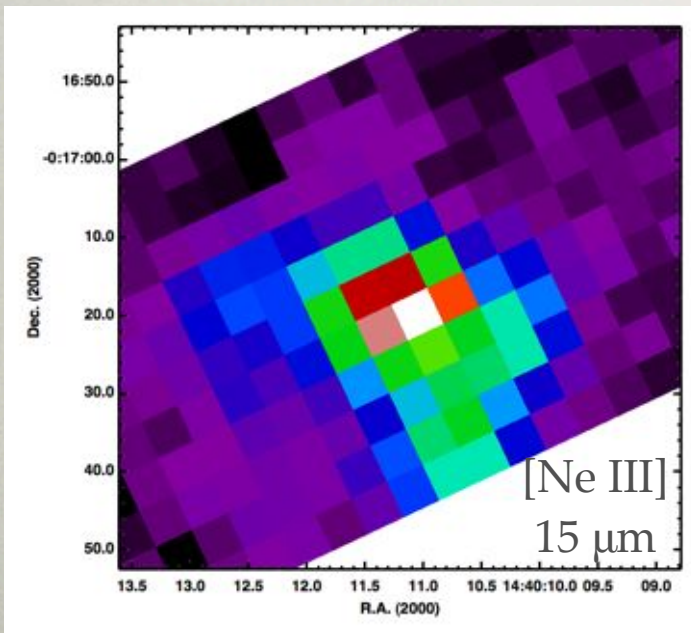
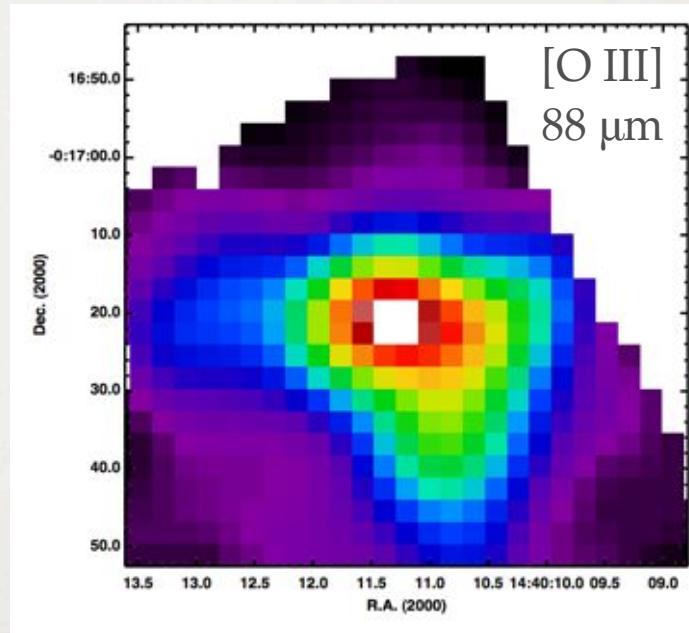
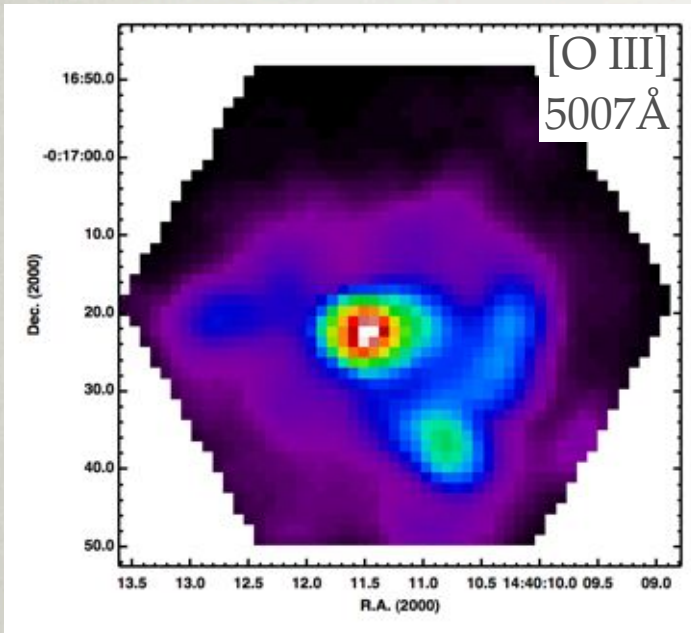
RESOLUTION: ISO VS HERSCHEL



- ISO
 - 70'' beam
- PACS
 - 8'' beam



WE MUST MATCH APERTURES

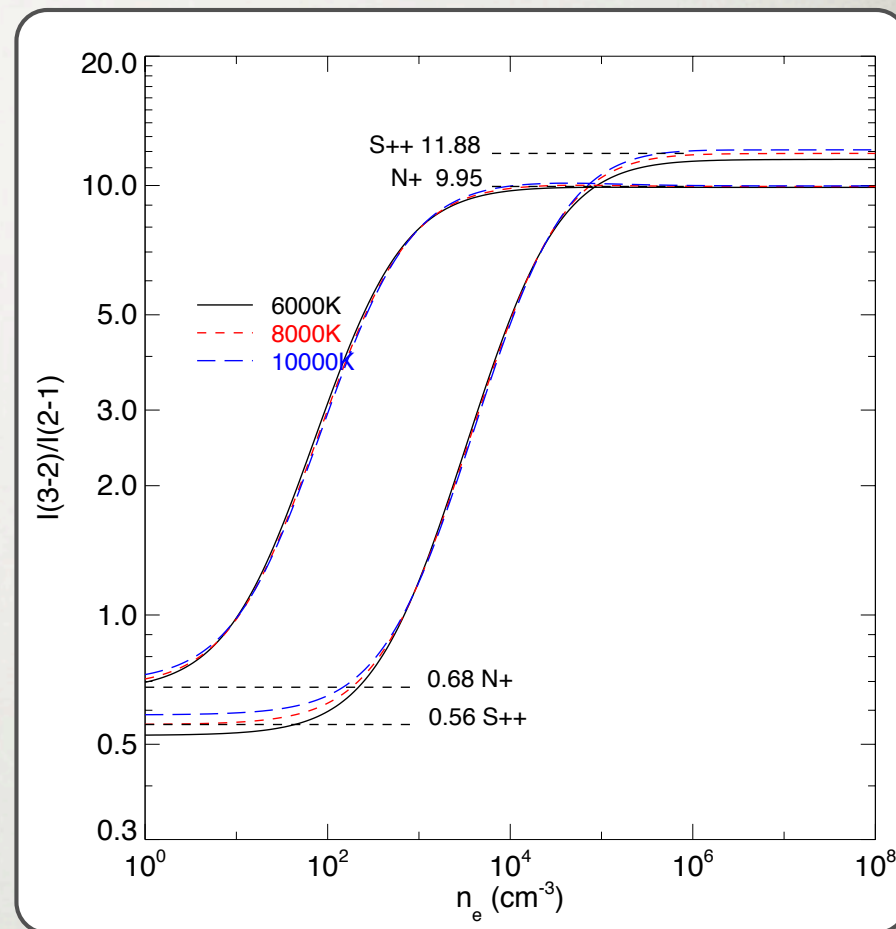
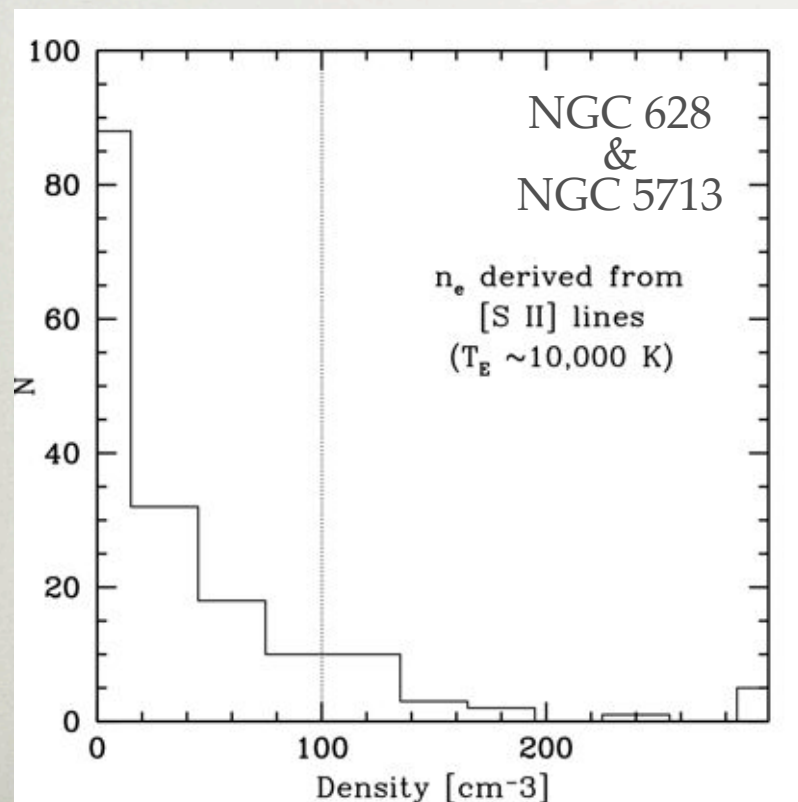


- Combine optical, mid-IR, and far-IR
- SINGS IRS spectra
- Long and Short slit spectra from the literature
- SINGS drift scan spectra

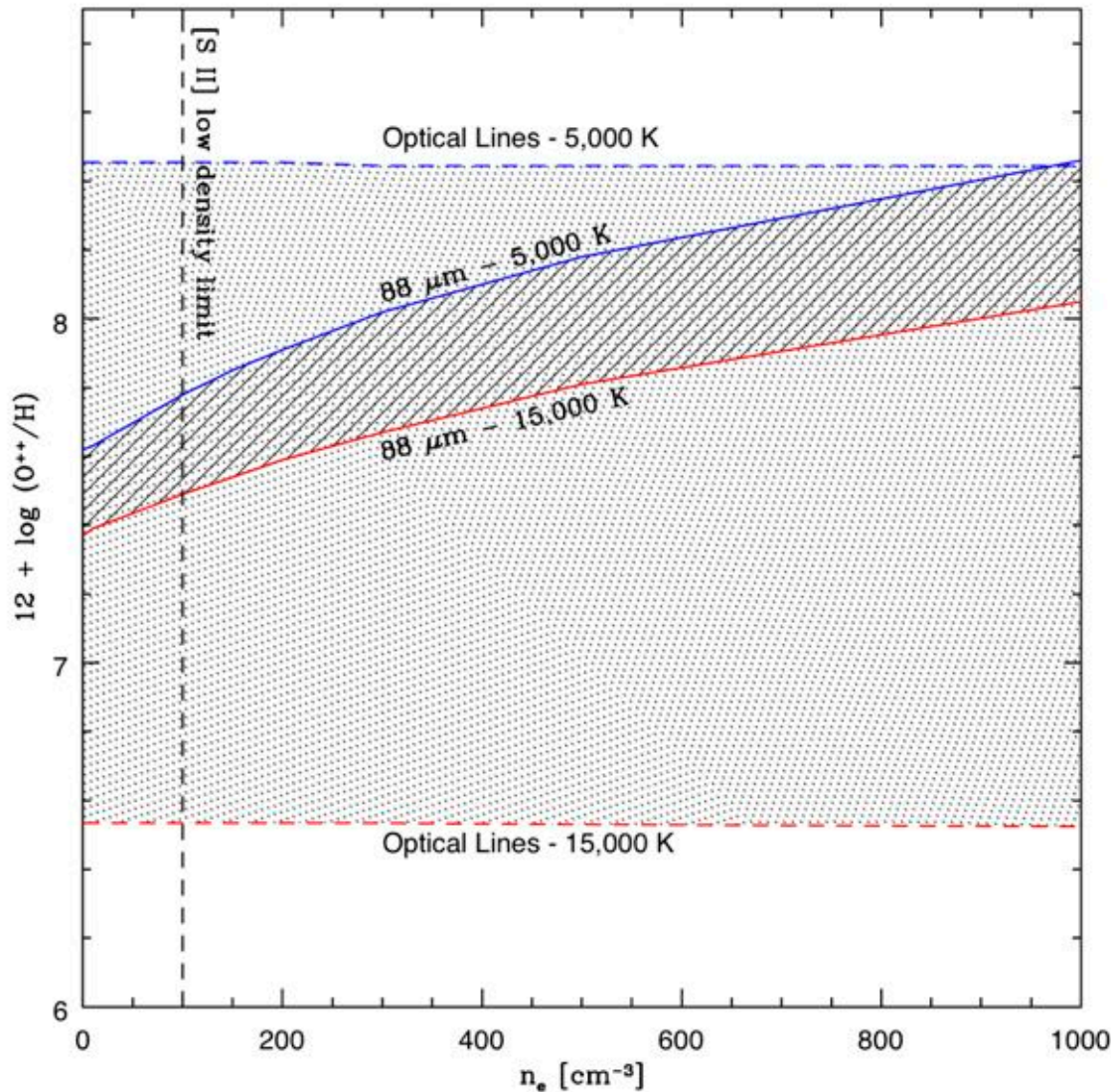


DENSITY DIAGNOSTICS

- [S III] 18/33 μm
- [S II] 6717/6733 \AA
- [N II] 121/205 μm
- [O III] 88/52 μm



COMPARING THE IR AND OPTICAL



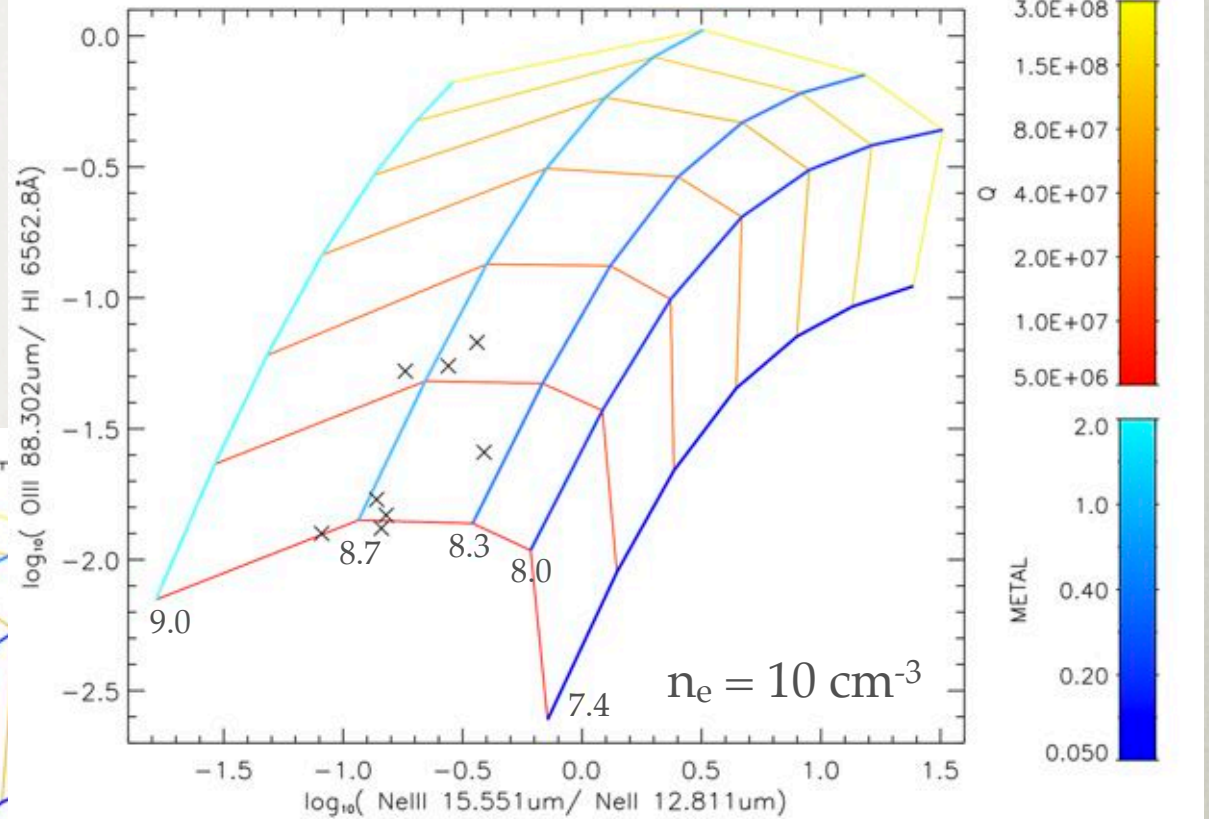
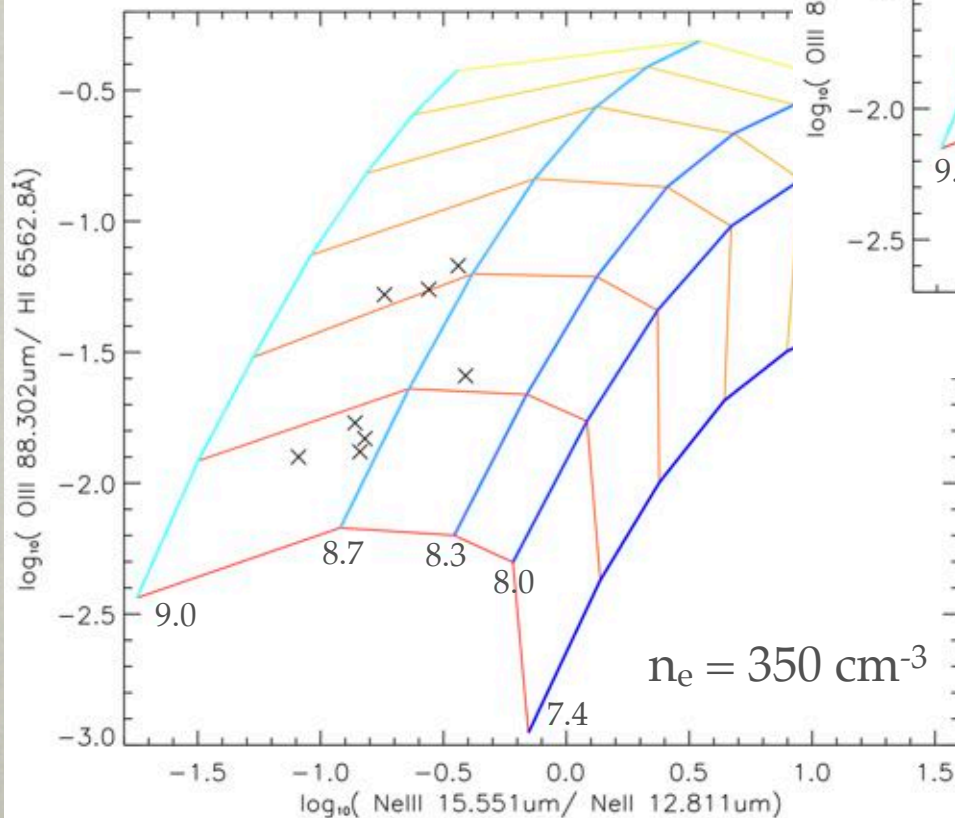
- We can limit the parameter space for the abundance of (O^{++} / H)
- Constraints on density further limit uncertainty
- We can use the 88 μm line to constrain the temperature



PRELIMINARY RESULTS - NGC 628

NGC 628

- $\text{KK04}_{\text{SINGS}} : 9.02 \pm 0.01$
- $\text{PT05}_{\text{SINGS}} : 8.35 \pm 0.01$
- $\text{IR} : \sim 8.7$



Mappings III
Models

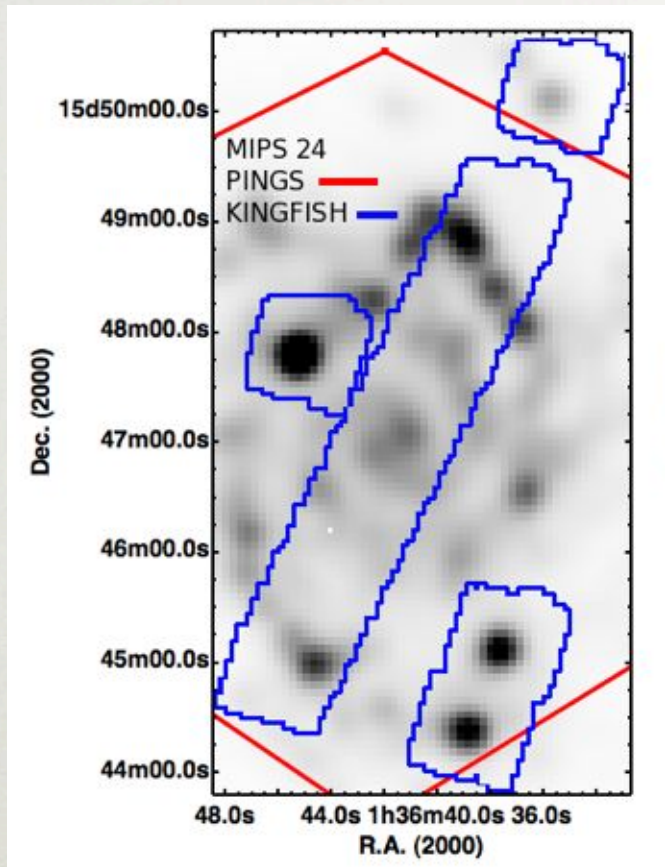


SUMMARY

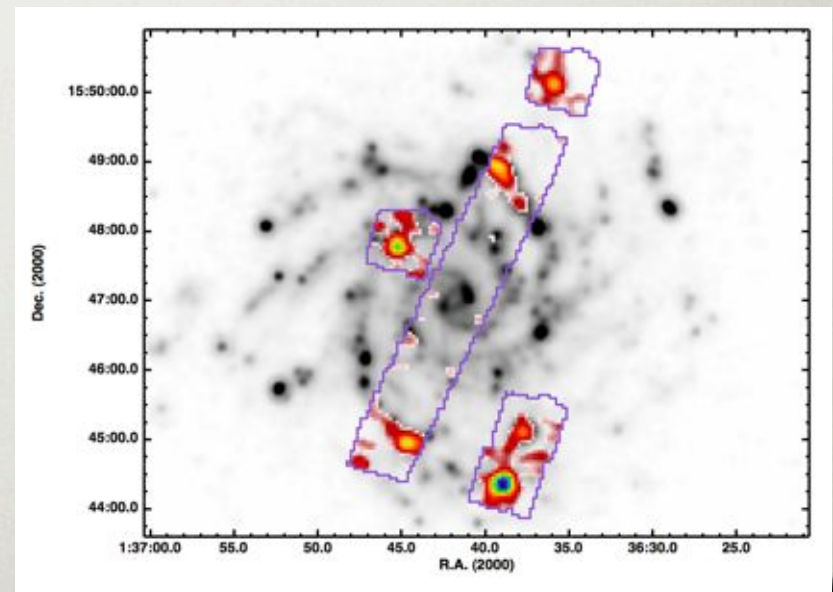
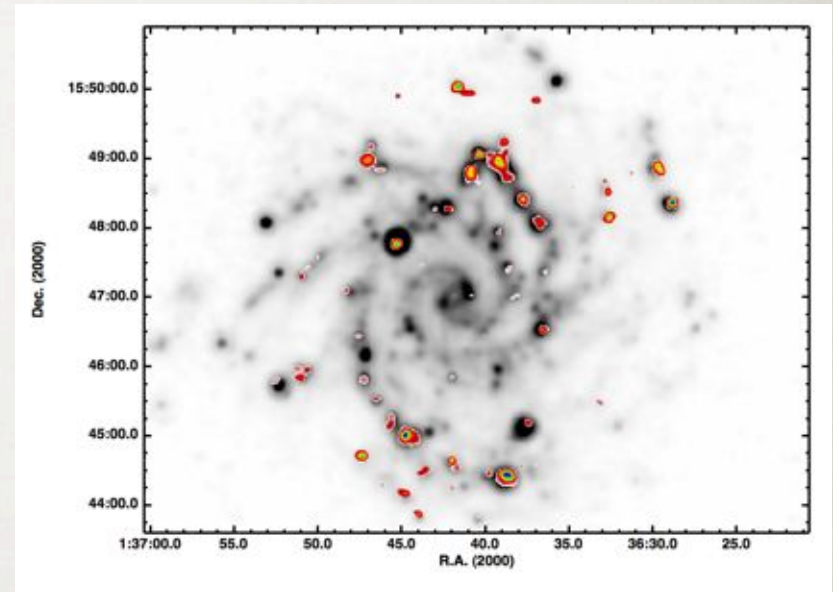
- High quality [O I] $63\mu\text{m}$ & [O III] $88\mu\text{m}$ maps have been obtained as part of KINGFISH (as well as [CII] and [NII]).
- [O III] emission in the Far-Infrared is significantly less sensitive to temperature.
- Plan: calibrate the nebular abundance scale independent of the temperature structure of HII regions.



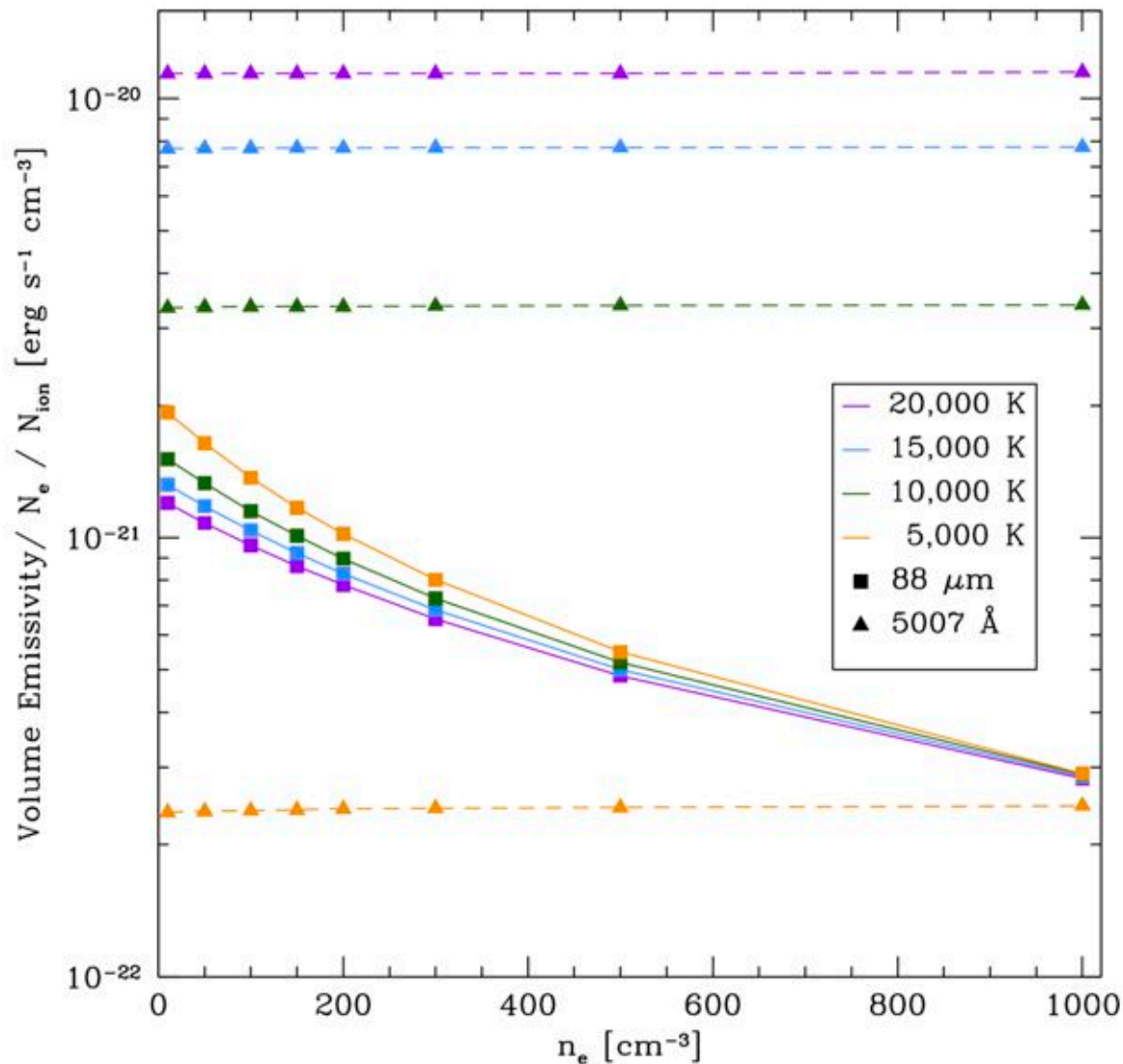
TEST CASE: NGC 0628



- Avoid *some* aperture issues by using mapping IFUs



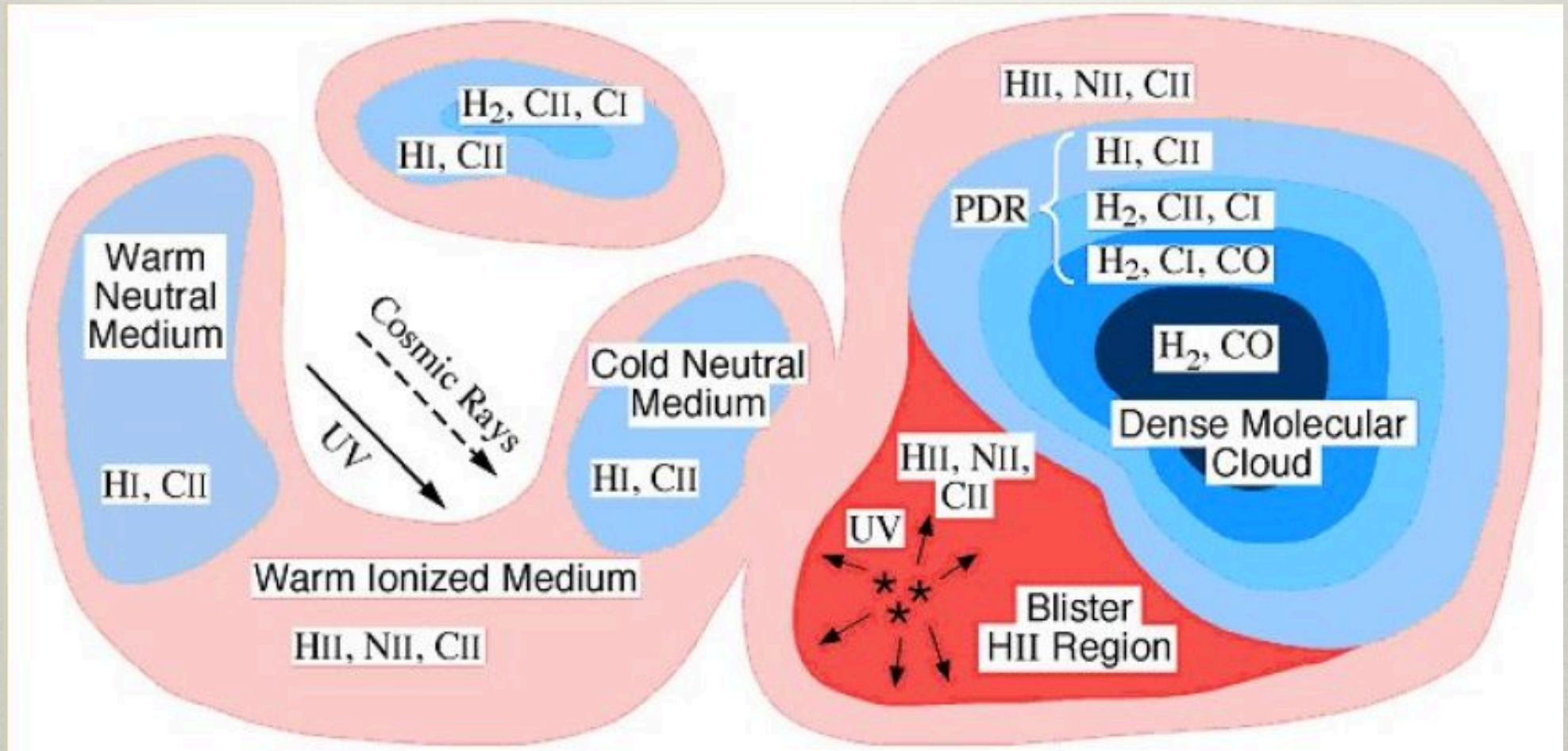
EMISSIONIVITY OF [O III]



Observing [O III]
in the FIR
drastically
reduces the
dependence of
emissivity on
temperature.



PHASES OF THE ISM



COURTESY CRAIG KULESA

