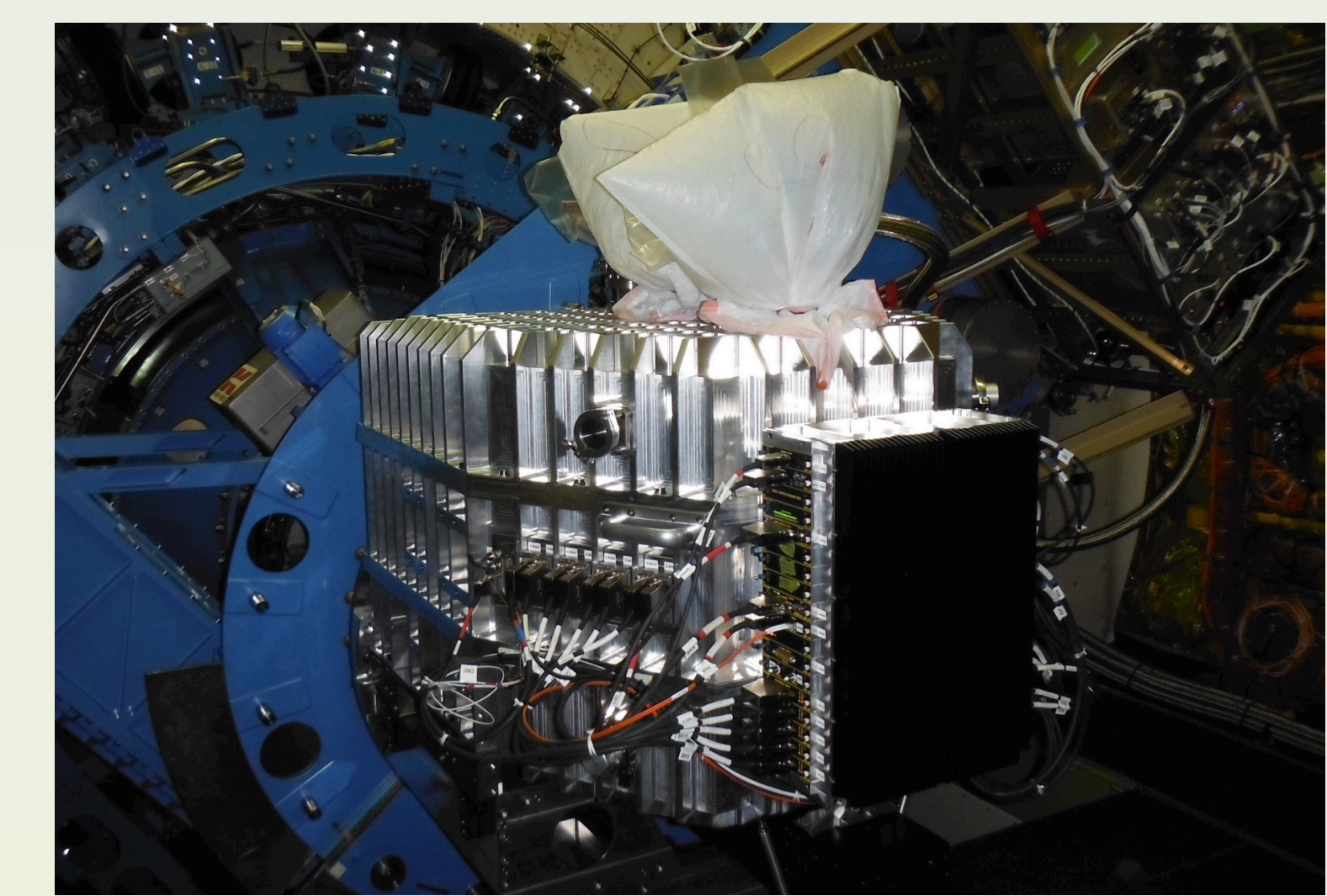




# How are molecular clouds eroded?

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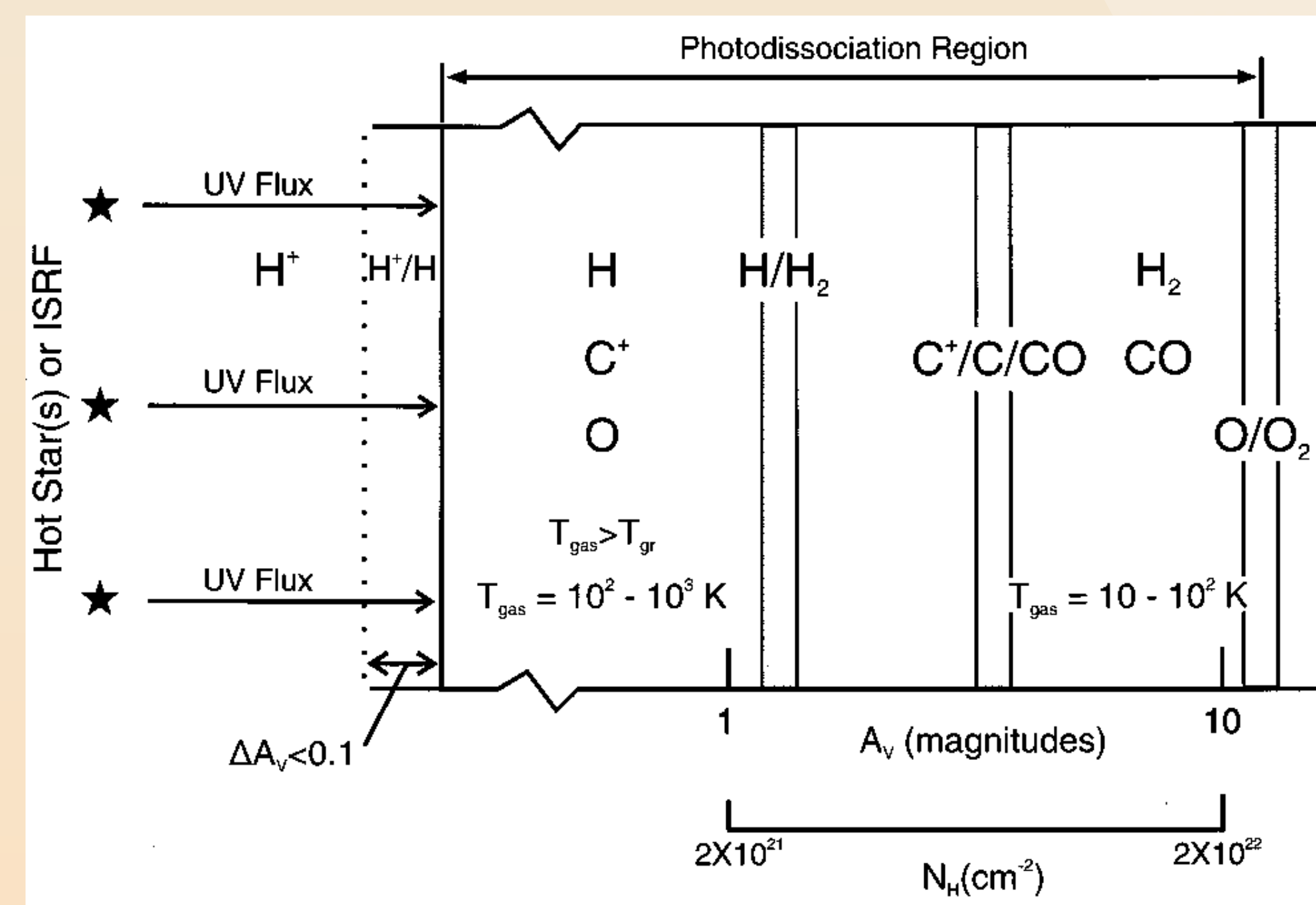


## ABSTRACT

PDRs are the places where molecular clouds are destroyed by UV radiation of forming massive stars allowing to study the stars' effect on the ISM. FIFI-LS is SOFIA's far infrared (FIR) spectrometer. Its wavelength range covers many strong fine-structure lines, which trace changes in densities and temperatures in the PDRs. Preliminary results of FIFI-LS observations of galactic PDRs are displayed. We obtained large maps in several transition of M42 and M17-SW and other galactic PDRs.

## PDRs

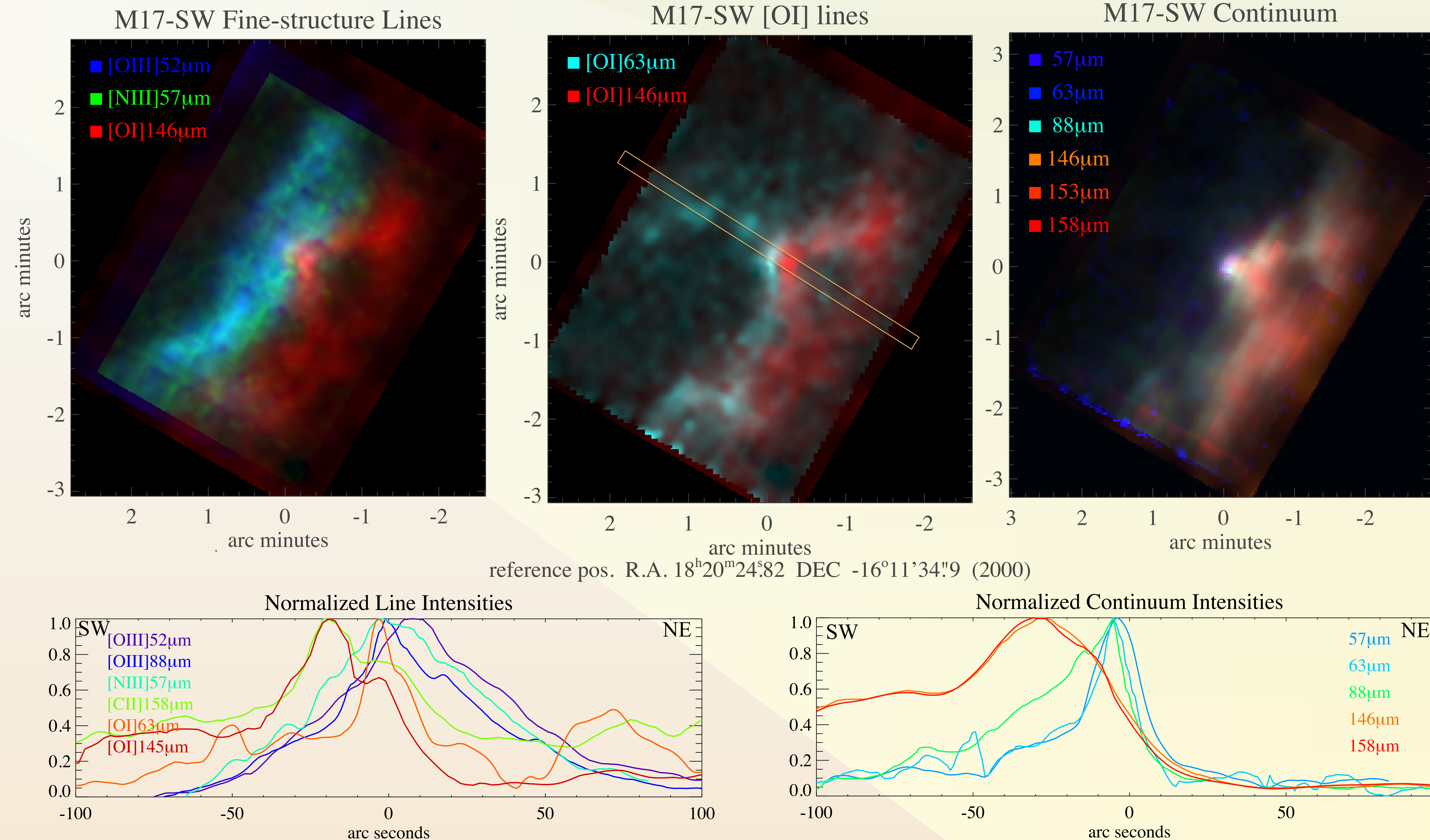
Photo-dissociation regions or photon-dominated regions (PDRs) are the interfaces between ionized HII-regions and adjacent molecular clouds. They appear typically in massive star-forming regions. The young massive (proto-)stars destroy their parental cloud with their UV radiation. As shown below (from Hollenbach and Tielens, 1999), the UV radiation, as it ionizes and dissociates hydrogen and other atoms and molecules, it creates layers on the surface of the molecular cloud, which can be traced in the FIR by fine-structure lines of oxygen and carbon, which happen to be the major cooling lines and diagnostics for density and temperature.



## MOTIVATION

FIFI-LS, with its ability to map FIR fine-structure lines fast and efficiently, has been used to map M42 and M17-SW in all the bright fine-structures lines. Tracing the intensity of these cooling lines will allow us to study in detail how the forming stars destroy the molecular cloud, how this feedback regulates star formation. *Analyzing the physical conditions and heating and cooling rates will provide observational clues as to which processes drive the cloud destruction: ionization, dissociation, or dust destruction.*

## M17-SW



## M17-SW

M17-SW is an edge-on PDR irradiated from the north-east. Embedded in the PDR is an ultra-compact HII region M17 UC1 (Felli et al, 1984). It is used as reference in the plots. The FIFI-LS maps from the left:

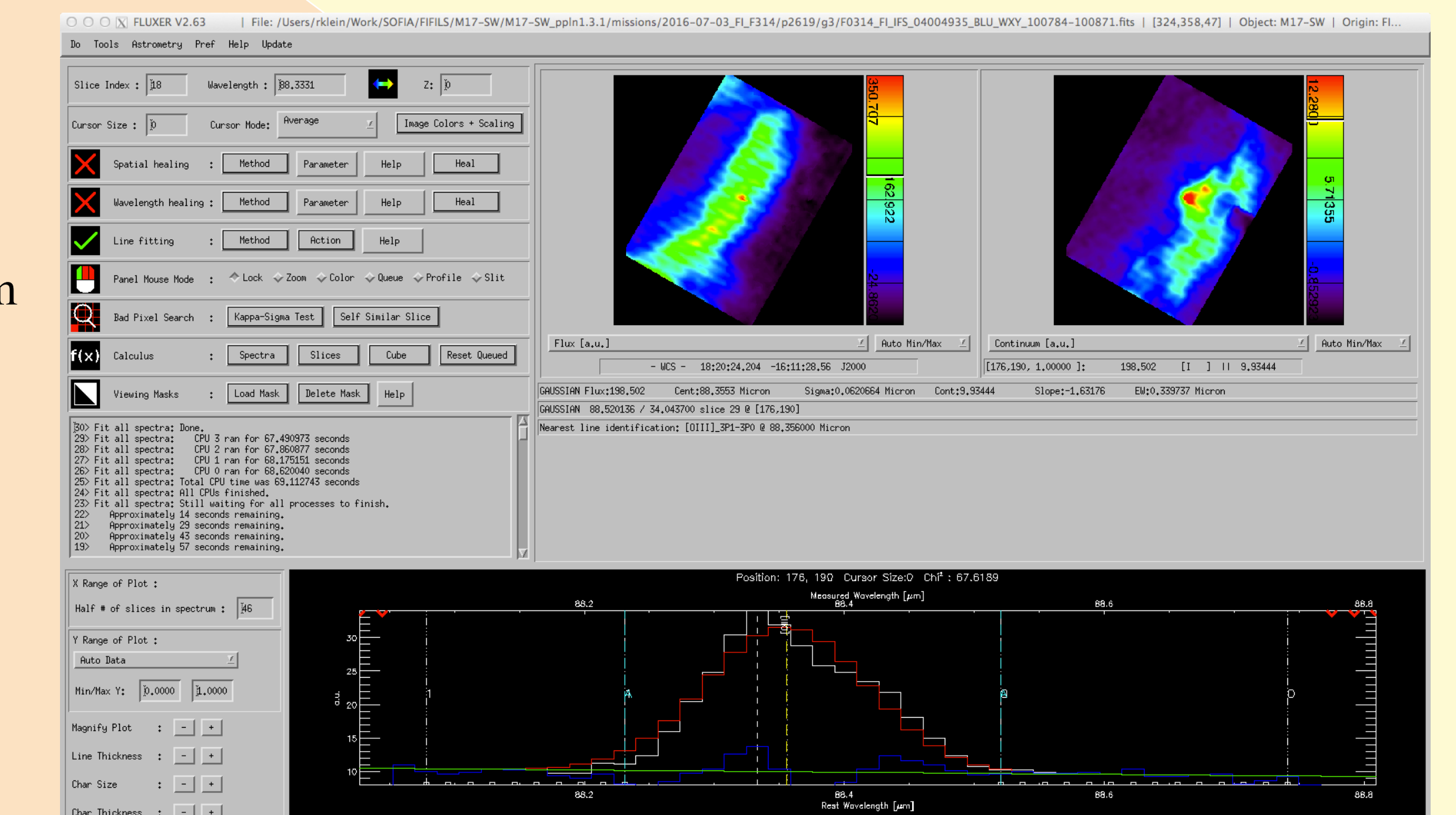
- Ions and neutrals are clearly layered. Also, see the plot of line intensities along the cut.
- The neutral oxygen line ratio varies with the 146μm line relative to the 63μm line gaining in strength in the denser molecular cloud.
- The peaks in the continuum emission from the molecular cloud also vary in position with wavelength indicating a heated surface. Also, see the plot of continuum intensities along the cut.
- Continuum and line emissions peak around UC1, but the peaks shift about 30" depending on wavelength and transition, respectively.

Like M42, M17-SW offers a laboratory for a detailed study of a PDR, how UV radiation erodes a molecular cloud. *The next step will be a quantitative analysis of line intensities and ratios to derive physical quantities, heating and cooling, and destruction rates.*

## DATA REDUCTION

The lines in the regions are so bright, that FIFI-LS's fast mapping mode was employed often even without overlapping the small "blue" field of view. The lack of overlap and imperfections in the flat-field lead to instrumental artifacts in the resulting images.

FIFI-LS's final data product is a data cube. To derive line flux and continuum maps, FLUXER<sup>1</sup> was used to fit a Gaussian plus a linear baseline to each spectrum in the data cube (screen shot below). If a strong telluric feature was within the spectrum, the baseline was fitted with ATRAN (Lord, 1992).



<sup>1</sup><http://www.ciserlohe.de/fluxer/fluxer.html>

## M42 - continuum at 158μm

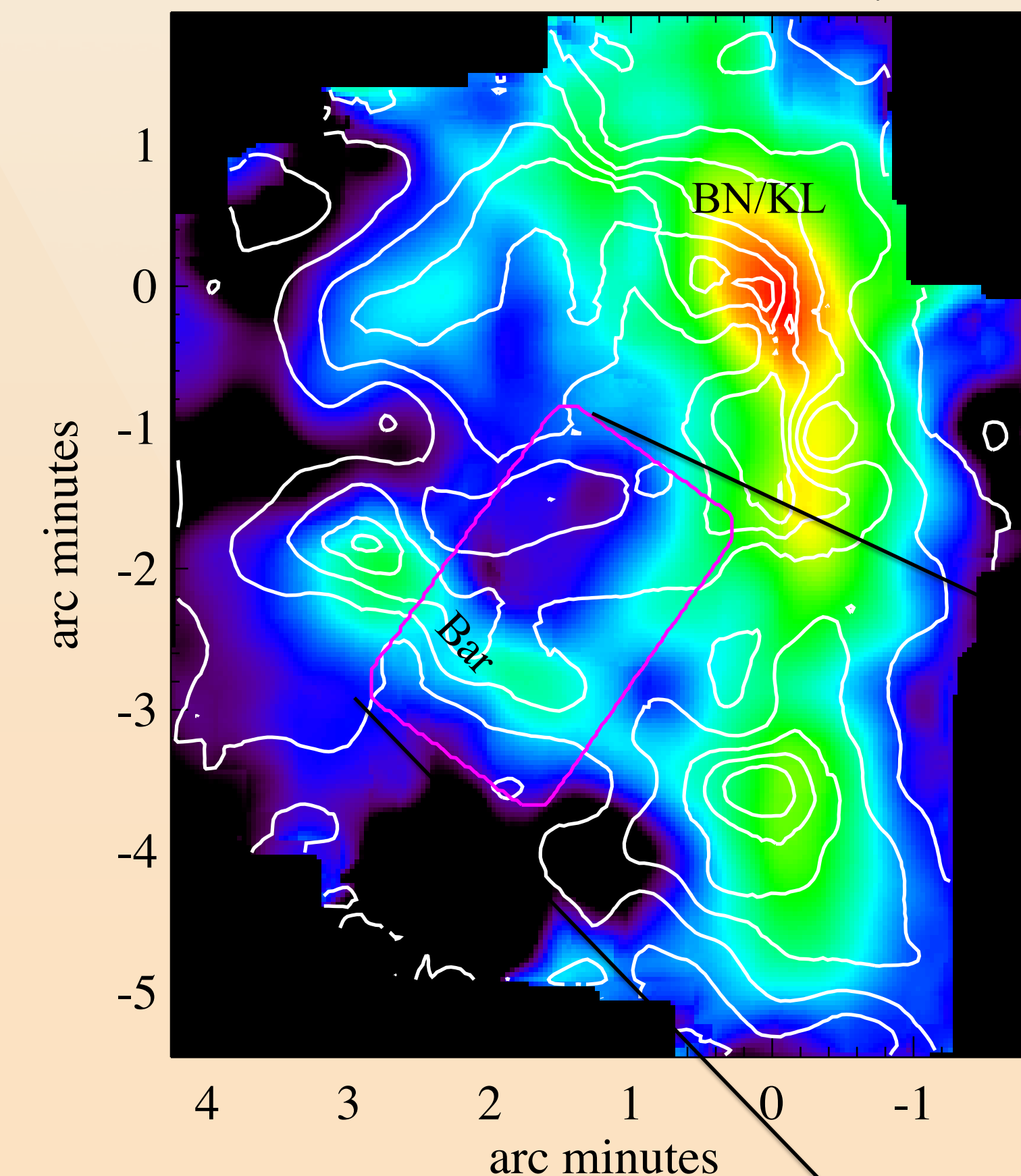


Image: log stretch; linear contours for [CII] flux

The continuum shows BN/KL, the bar and more of the cloud surrounding the HII region.

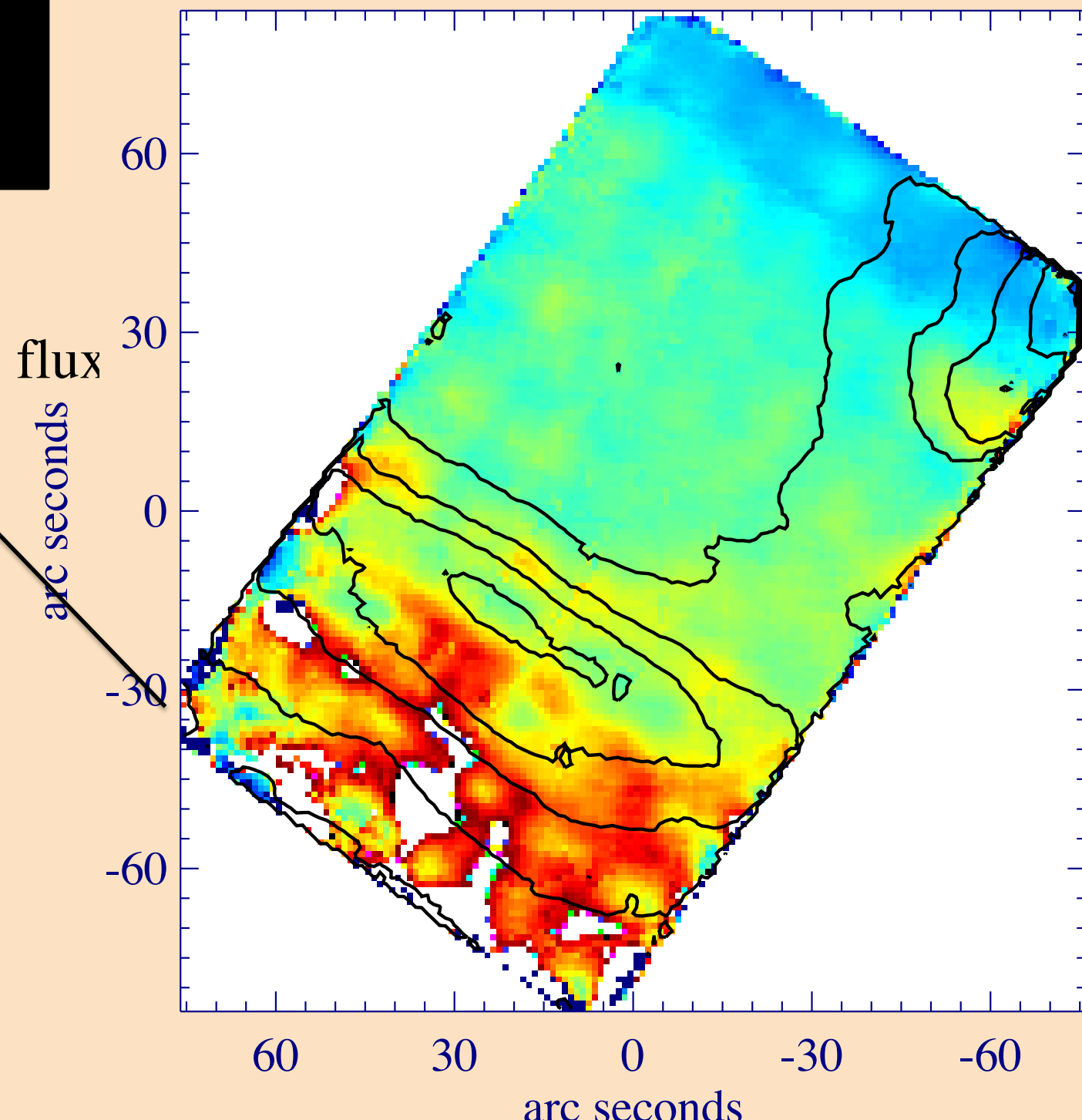
## M42

FIFI-LS obtained large maps of M42. Here is a small sampler:

[CII]: Wide spread, strong in cavity cleared by the Trapezium, peaks along cavity walls.

[OIII] ratio: temperature and density indicator

[OIII] line ratio (f88/f52); 88μm cont



## M42 - [CII] flux

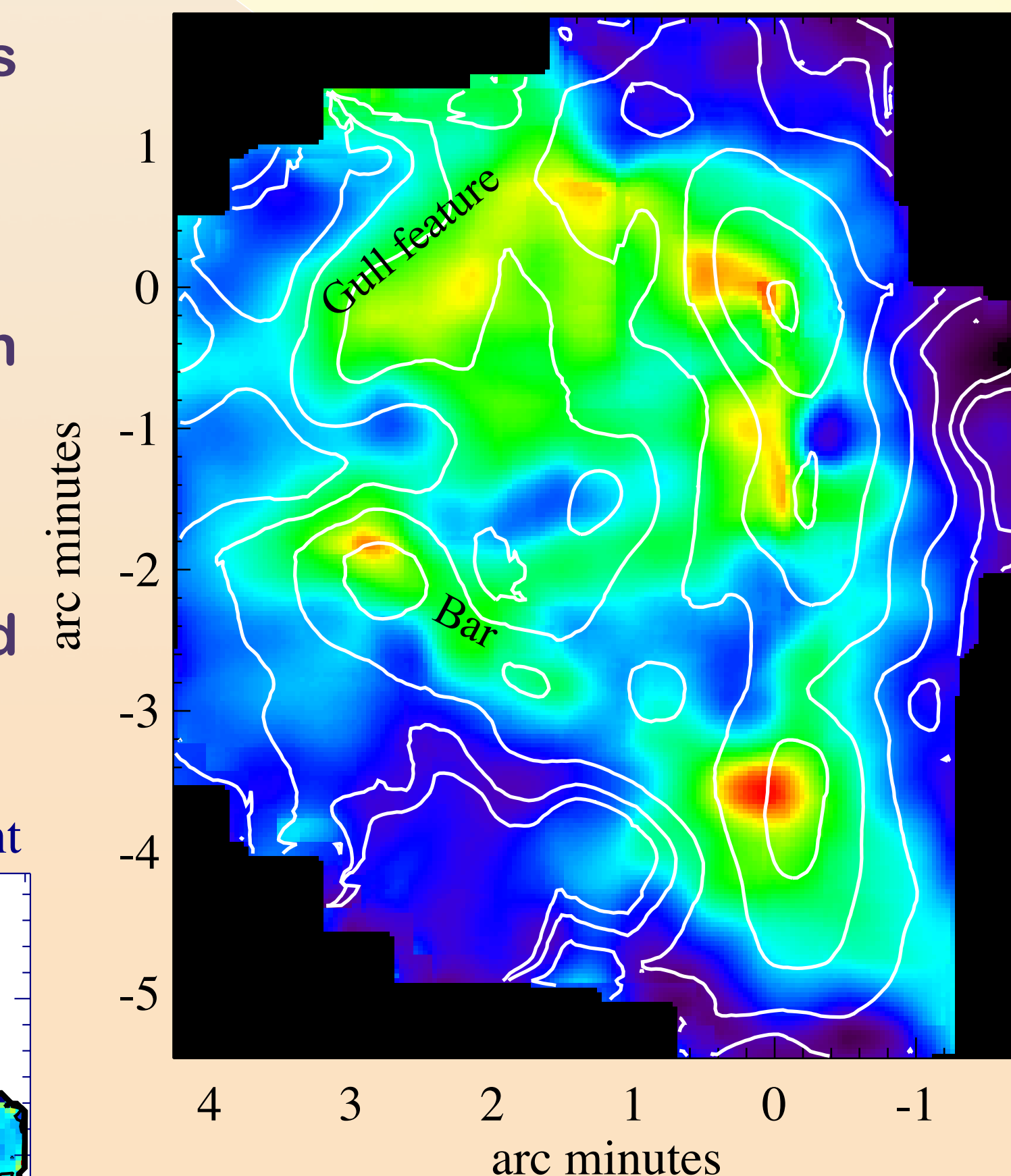


Image: linear stretch; log contours for 158μm continuum

Preliminary results:

The [OIII] line ratio varies from the HII region into the bar: T<sub>e</sub> ~10<sup>4</sup>K; N<sub>e</sub> ~10<sup>3</sup>cm<sup>-3</sup>. The increase towards the bar indicates an increase in density.