STAR FORMATION RATE IN THE UV-BRIGHTEST HII REGION OF NGC6946, THE FIREWORKS GALAXY

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We present initial results from our ongoing analysis of the multi-wavelength (UV - radio) spatially resolved emission from nearby galaxies in order to derive the spatial variations of their physical properties such as: their current star-formation rate and star formation history; their stellar content; and the distribution of dust masses and infrared emission between the different gas phases of their interstellar medium.
Our work has started with the nearby galaxy NGC 6946 (at ~ 6.8 Mpc). The radio data have been used to separate free-free from synchrotron emission across the galaxy. The free-free emission is a powerful tracer of star formation, which is especially strong in a few dozen star-forming complex along the galaxy's spiral arms. Here we show the detailed analysis of one bright HII region complex.

DATASET

- GALEX FUV (1528 Å; 4.2'') and NUV (2271 Å; 4.2'') [1]
- KITT PEAK B (4400 Å), V (5500 Å), Hα (6573 Å) [2]
- 2MASS J (1.23 µm; 3''), H (1.66 µm; 3''), and K (2.16 µm; 3'') [3]
- SPITZER IRAC 3.6 µm (1.7''), 4.5 µm (1.7''), 5.6 µm (1.9''), and 7.9 µm (2'') [2]
- ISO ISOCAM (15 µm; 3.5'') [4]
- SPITZER MIPS 24 µm (6'') [2]
- HERSCHEL PACS 70 µm (5.2''), 100 µm (7.7''), and 160 µm (12'') [5]
- HERSCHEL SPIRE 250 µm (18'') and 350 µm (25'') [5]
- VLA 3.5 cm (15''), 6 cm (15''), and 20 cm (15'') [6]
- WSRT 18 cm (14''x 12.5'') and 22 cm (14''x 12.5'') [6]

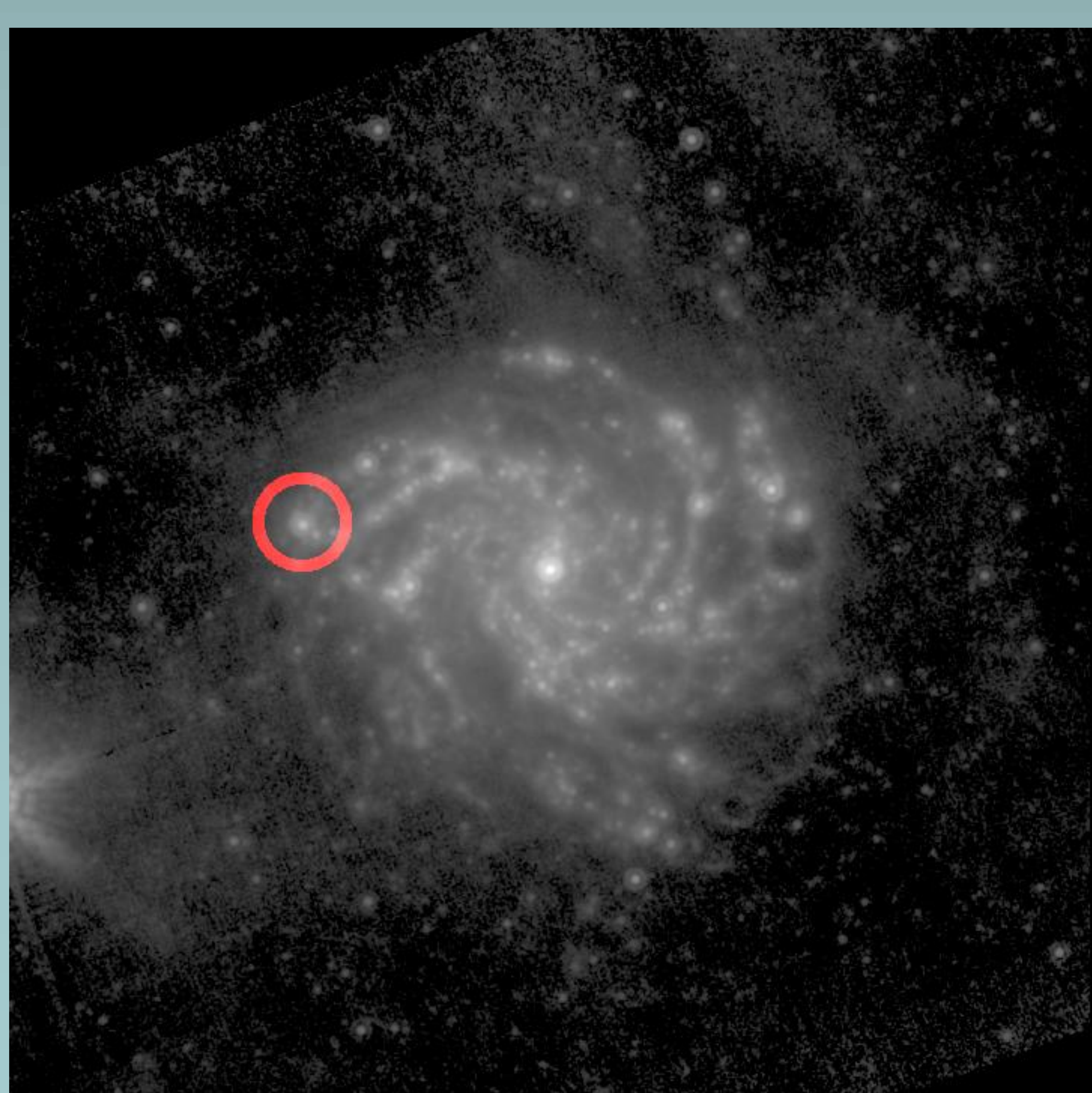


Fig. 1: MIPS 24 µm image of NGC6946. The red annulus (37.5'' < r < 50'') shows the background region centered at the Extranuclear Region 2 (Enuc.2; R.A. J2000 20:35:25.49 Decl. +60:11:1.1 [10]).

Data Reduction

- The data were convolved to a common 25'' FHWM resolution (limited by Herschel SPIRE 350 µm) and reprojected to a common astrometric grid. All units were converted to MJy/sr.
- We performed single pointing photometry (spp) on the maps. The fluxes report the peak value multiplied by the effective area of the beam, subtracting the median of the pixels in the annulus shown in Fig. 1.
- At 25'' resolution Enuc. 2 is unresolved at all wavelengths, which made spp less affected by confusion than aperture photometry.
- The error bars account for the background pixels variance and the calibration uncertainties.

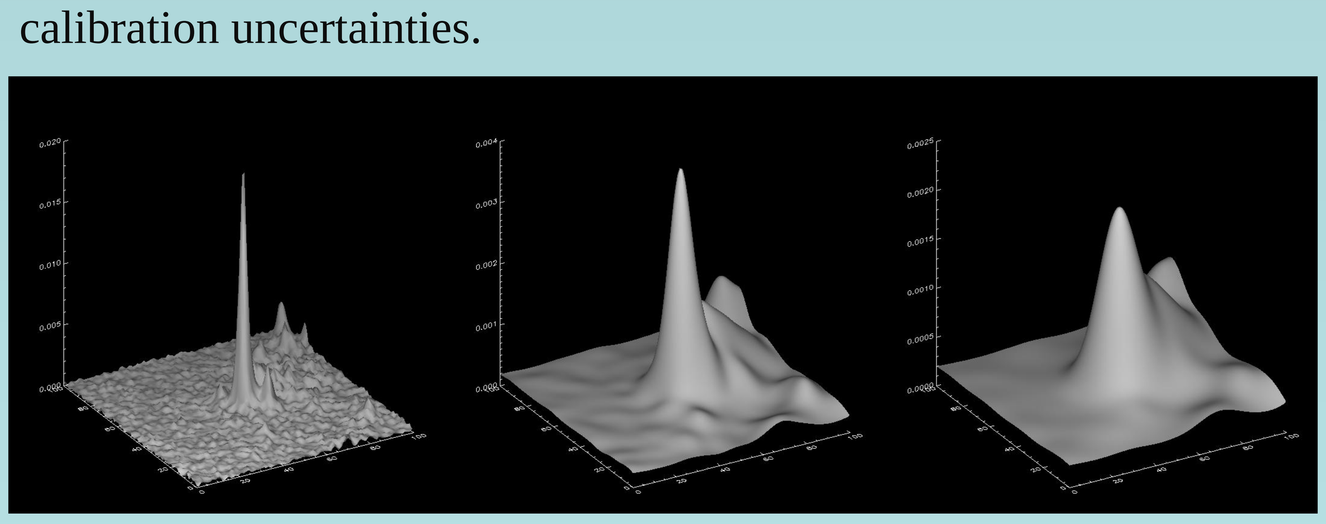


Fig. 2a, 2b, and 2c: 150''x150'' GALEX FUV crop around Enuc. 2 showing the native resolution, and convolved to 15'' and 25''.

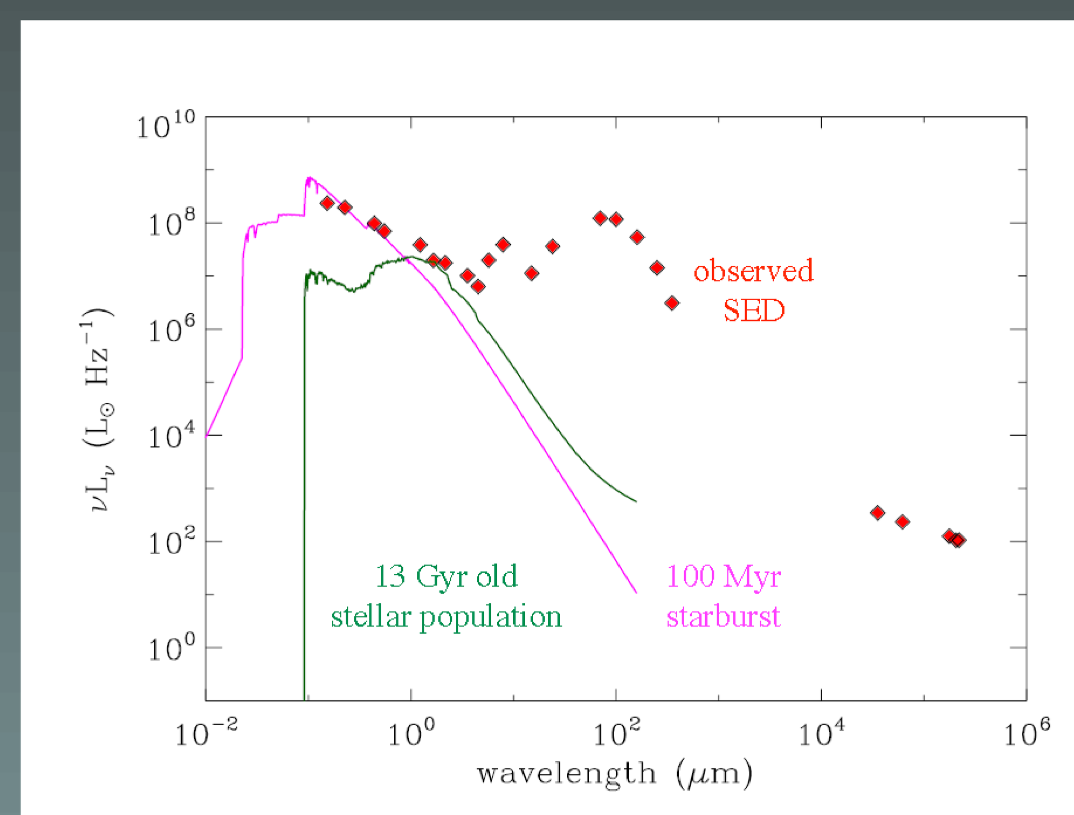


Fig. 3a: We start with a stellar population consisting of: (1) a young starburst, which provides the bulk of the luminosity and all of the ionizing radiation; and (2) an older population, which provides additional NIR emission. Stellar populations were modeled with PÉGASE [7], using a Kroupa IMF [8].

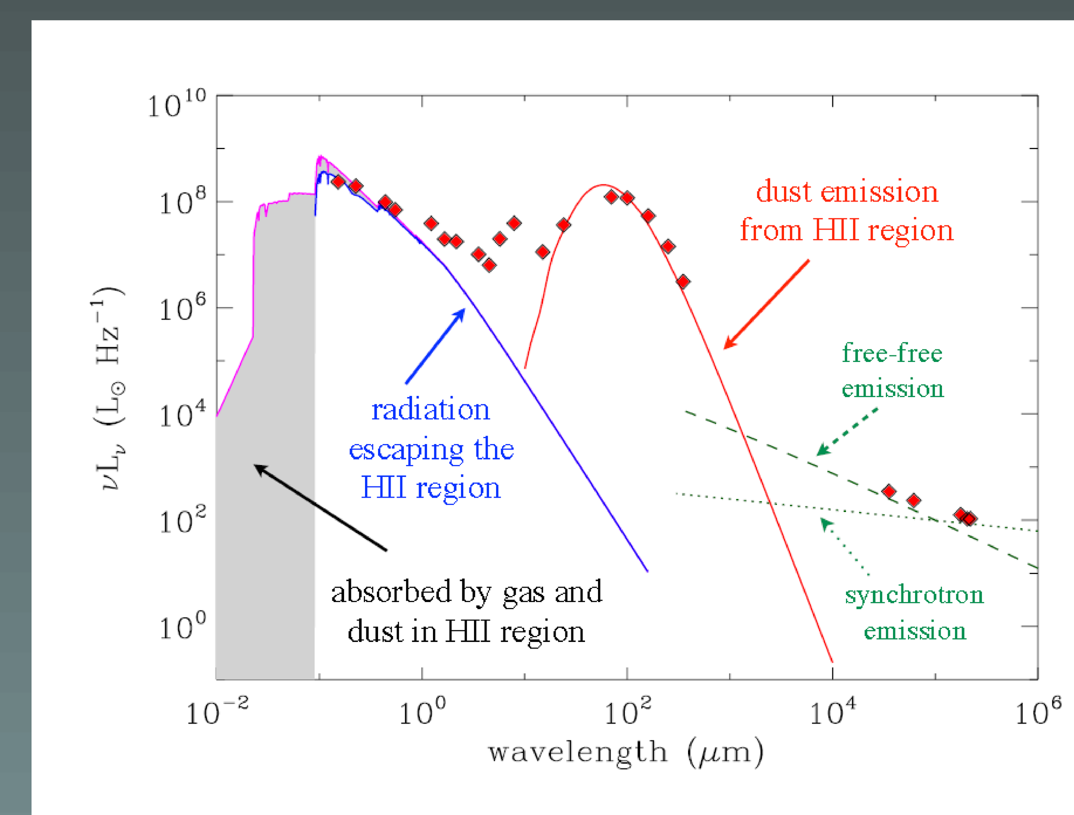


Fig. 3b: Dust and gas in the HII region absorbs UV and optical light, reemitting the energy at FIR and radio wavelengths (thermal emission). The model keeps track of the thermal radio emission, Hα, Hβ, and Paα. From previous radio decomposition, the free-free emission is about 90% of the total flux at 3.5 cm.

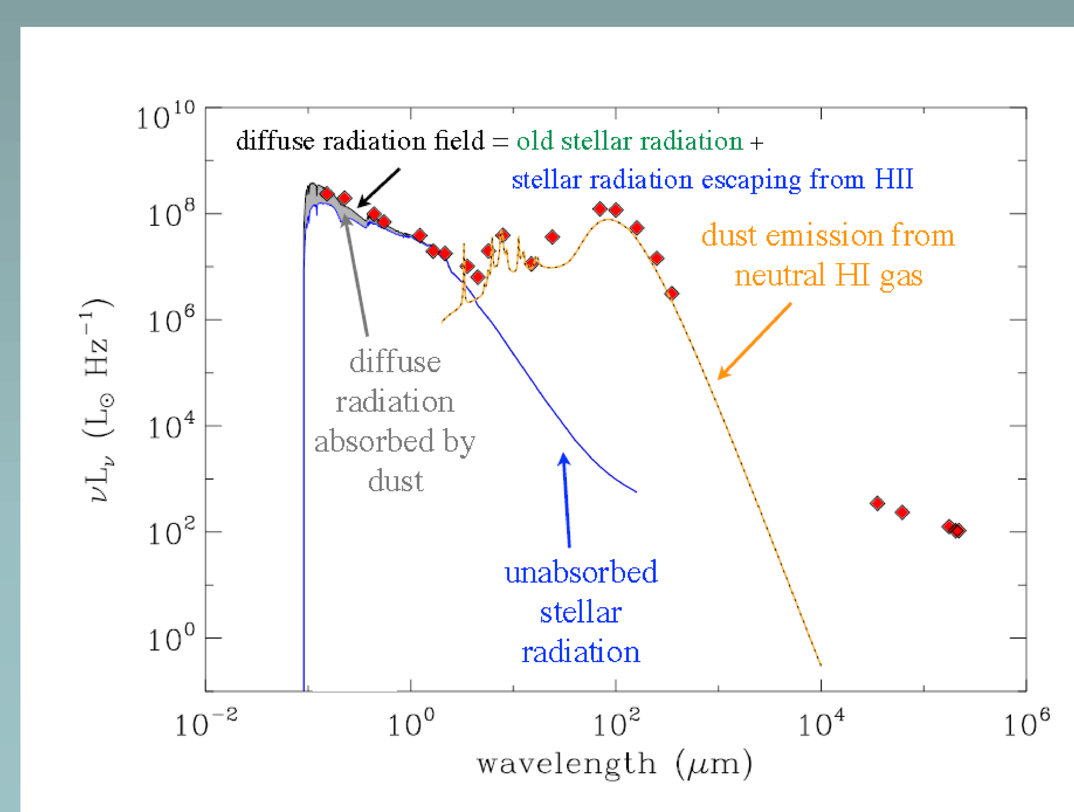


Fig. 3c: Starburst radiation escaping the HII region and the non-ionizing radiation from the old stellar population are absorbed (stochastically[11]) and reemitted by dust in the surrounding neutral gas.

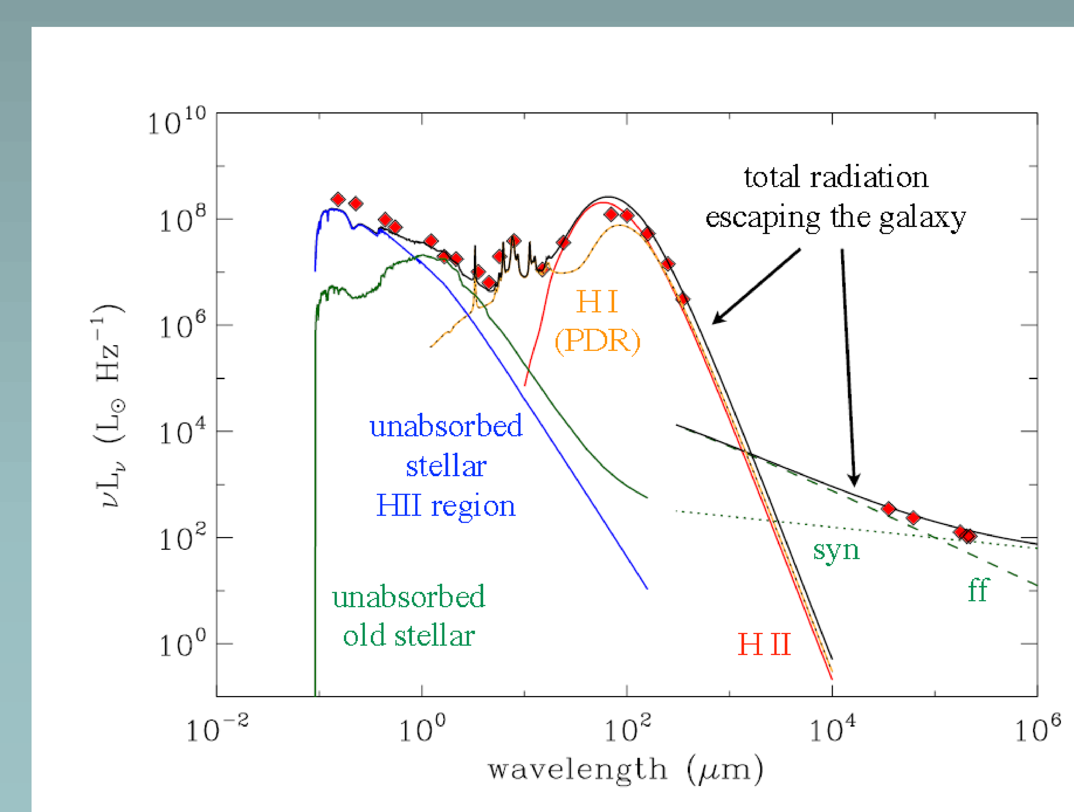


Fig. 3d: The observed emission consists of all unabsorbed stellar radiation, the IR emission from the HII regions and the neutral gas, and the radio emission.

Results:

1. Energetics

$$L_{Star}(esc) = 2.2\times10^{8}\ L_{\odot}$$

$$L_{IR}(H\ II) = 2.5\times10^{8}\ L_{\odot}$$

$$L_{IR}(H\ I) = 1.2\times10^{8}\ L_{\odot}$$

2. Star Formation Rates

$$SFR_{starburst} = 0.058\, M_{\odot} yr^{-1}$$

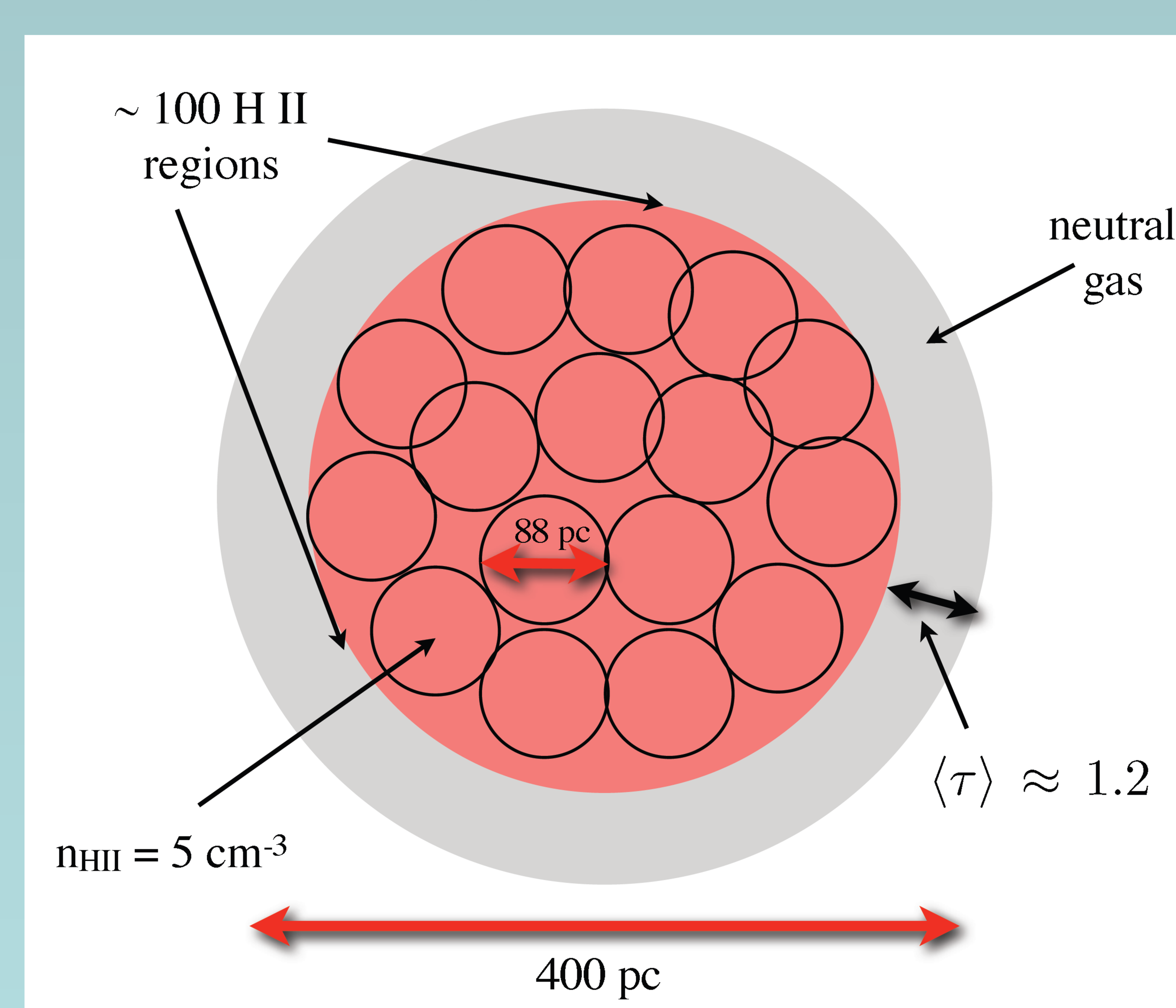
$$SFR_{old} = 0.002\, e^{-(t/\mathrm{Gyr}-13)/5}\, M_{\odot} yr^{-1}$$

3. Dust Masses

$$M_{dust}(H\ II) = 3\times10^{4}\ M_{\odot}$$

$$M_{dust}(H\ I) = 8\times10^{6}\ M_{\odot}$$

4. HII Complex Morphology



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