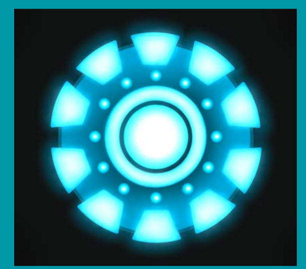

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Discerning Active galactic Regions using Cloudy

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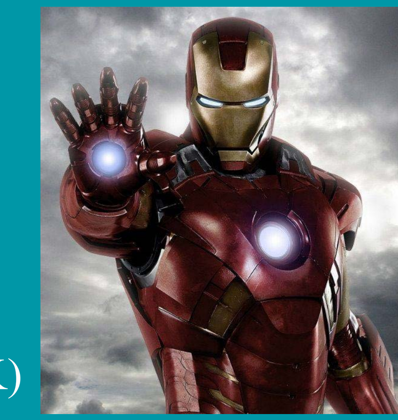


Abstract

CLOUDY photoionization code is used to simulate various AGN models, taking into account different inclination angles and cases for intensity and luminosity with varying radii. We introduce a dust+gas slab placed at a specific distance from the central source and going upto $N_H = 10^{24}$ cm^{-2}. We study the dependence of the illumination angle on the geometry and composition of the slab. Line ratios have been computed for these models, agreeing to the BPT diagnostics for the Narrow Line Regions (NLR). We also model the line emissivities in the broad line regions (BLR) for certain selected elements in specific ionizing states. We find our CLOUDY simulations to be consistent to the observations from archival data taken at different energy bands.

BPT Diagrams

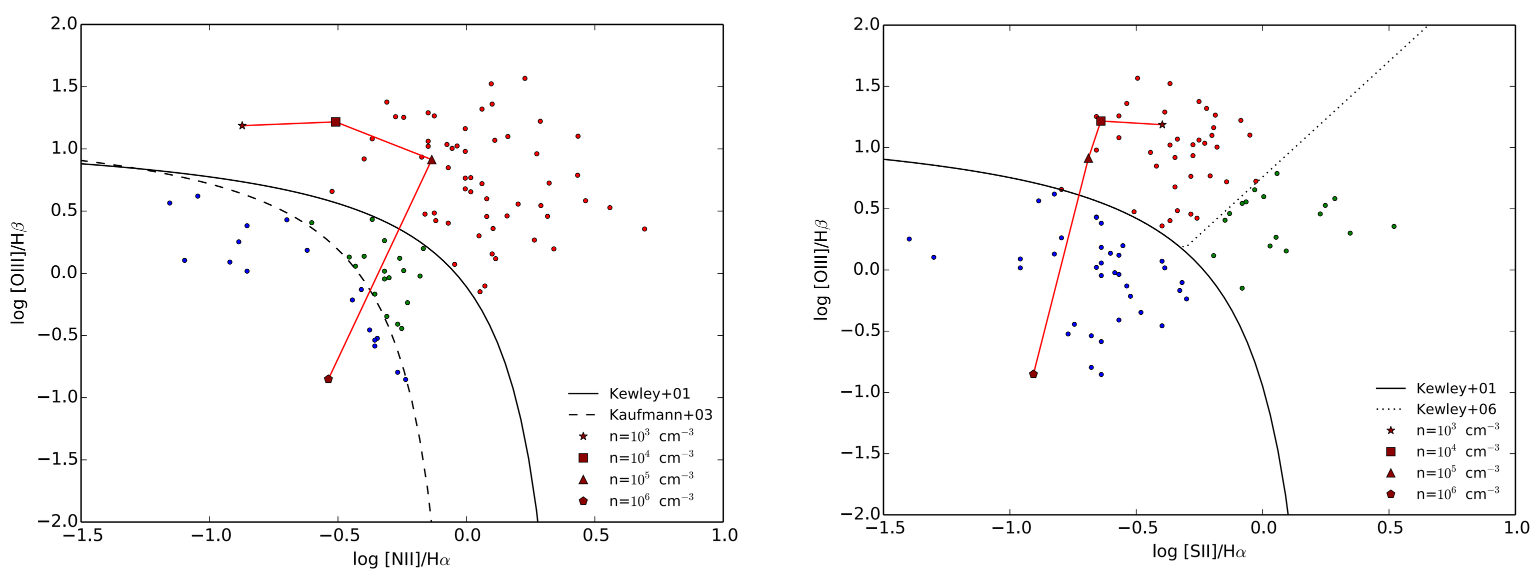
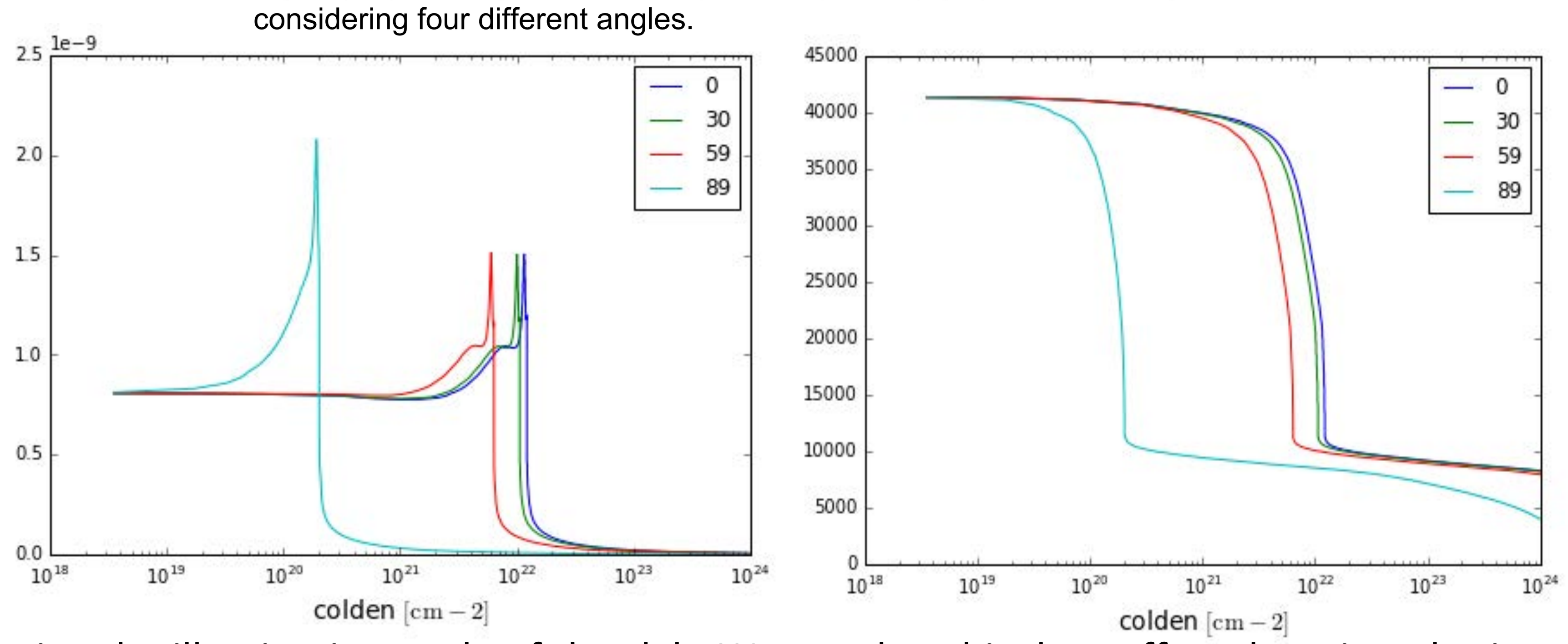


Fig 1. [NII]/Hα and [SII]/Hα versus [OIII]/Hß BPT diagrams. The CLOUDY models are derived for four different densities (log n =[3-7] cm-3) overplotted to observed data.

- BPT (Baldwin, Phillips & Terlevich, 1981) diagrams are optical diagnostics that allow to disentangle different forms of ionization mechanism (star-formation, AGN, LINERs/shocks).
- We find that the line ratios have no exact dependence with respect to the illumination angle, but they do change with varying densities. The [OIII] and [SII] line emissions go down with increasing densities because the ionizing parameter decreases. Results are shown in Fig. 1.
- Using the simulations by varying mean hydrogen densities and illumination angles, we compare the results with data from (Brightman et al. 2011).

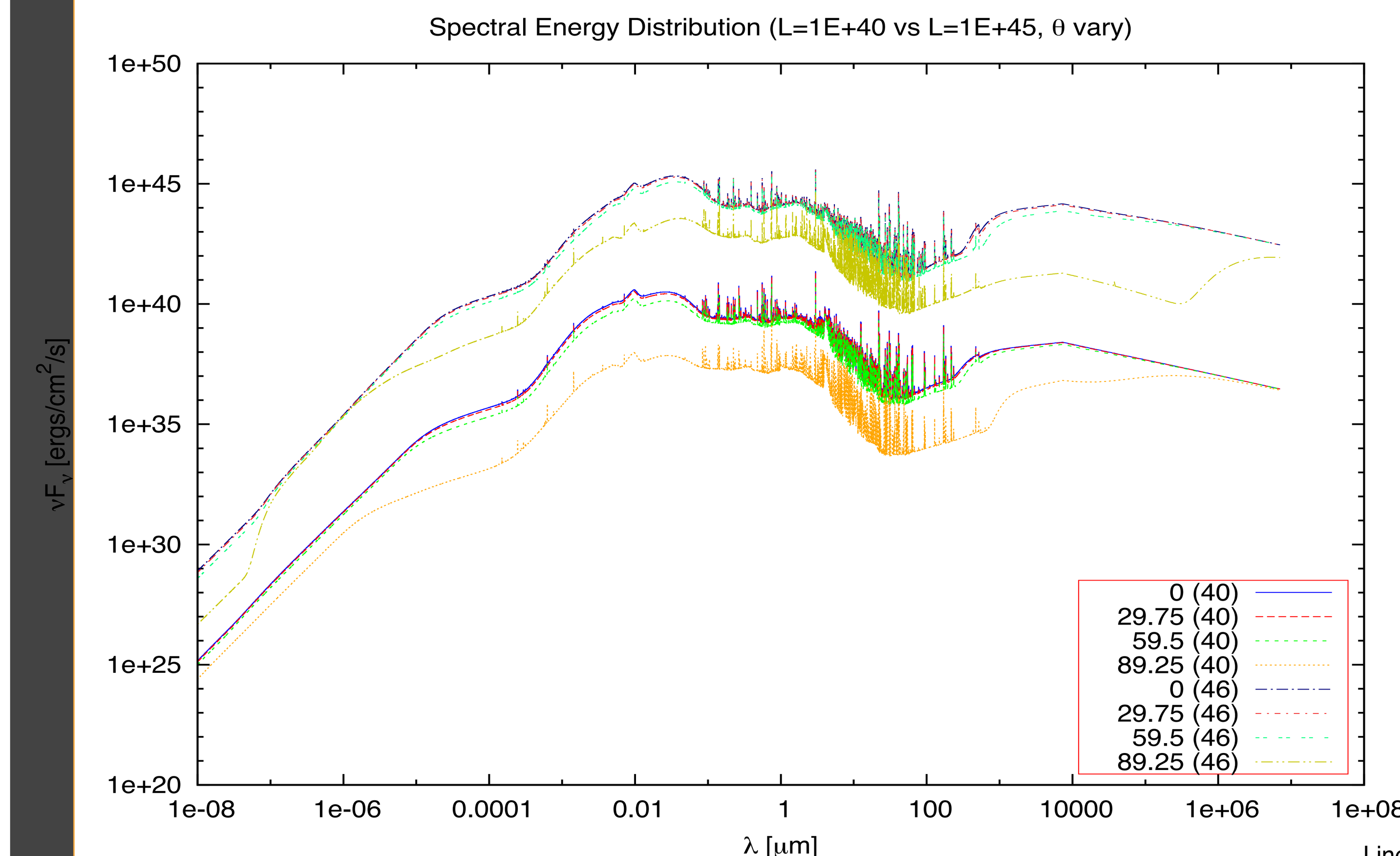
Cooling and Temperature profile

Fig 3. (left) Cooling rate and temperature profile (right) for increasing column densities considering four different angles.



- We analyze how the geometry affects the microphysical properties of the illuminated medium.
- We consider an AGN illuminating a slab of dust and gas, ranging from his sublimation radius up to 10^{24} cm^{-2} column density.
- We alter this configuration by varying the illumination angle of the slab. We see that this does affect the microphysics of the dusty cloud. Fig 3. shows how cooling and temperature profile for four different angles: the cooling and the temperature profiles peak at a lower column denstiy as the illumination angle approaches the 90°.

Spectral Energy Distribution (SED) and line emissivity



- We constructed different SED plots by varying the illumination angle i.e., how differently does our slab gets illuminated by the incident radiation from the central source. We considered 4 equi-spaced angles from 0° to 89.25° for the test and two values for the luminosity (log L = 40 [erg s^{-1}] and log L = 46 [erg s^{-1}]) for comparison.

Fig 2. Spectral Energy Distributions (SEDs) of a gas+dust slab illuminated by an AGN, placed at 10^{16} cm from the central source, taking into account four different incident angles (0°,29.75°,59.5°,89.25°) for two intrinsic luminosities (log L = 40 erg s^{-1} and log L = 46 erg s^{-1}).

- We compared the two extreme illumination angle cases for a fixed luminosity to study line emissivities for certain elements as a function of the depth in the slab.
- Note the significant shift between the extreme angles (both in the case of the SEDs and the emissivities profiles) that can be linked to the "limb darkening" effect. This phenomenon explains the reason behind the slump in the total energy output as we go from 0 ° to 90°.
- We looked into archival data (opt-UV and IR) to find observations to compare to the results of the CLOUDY simulations.

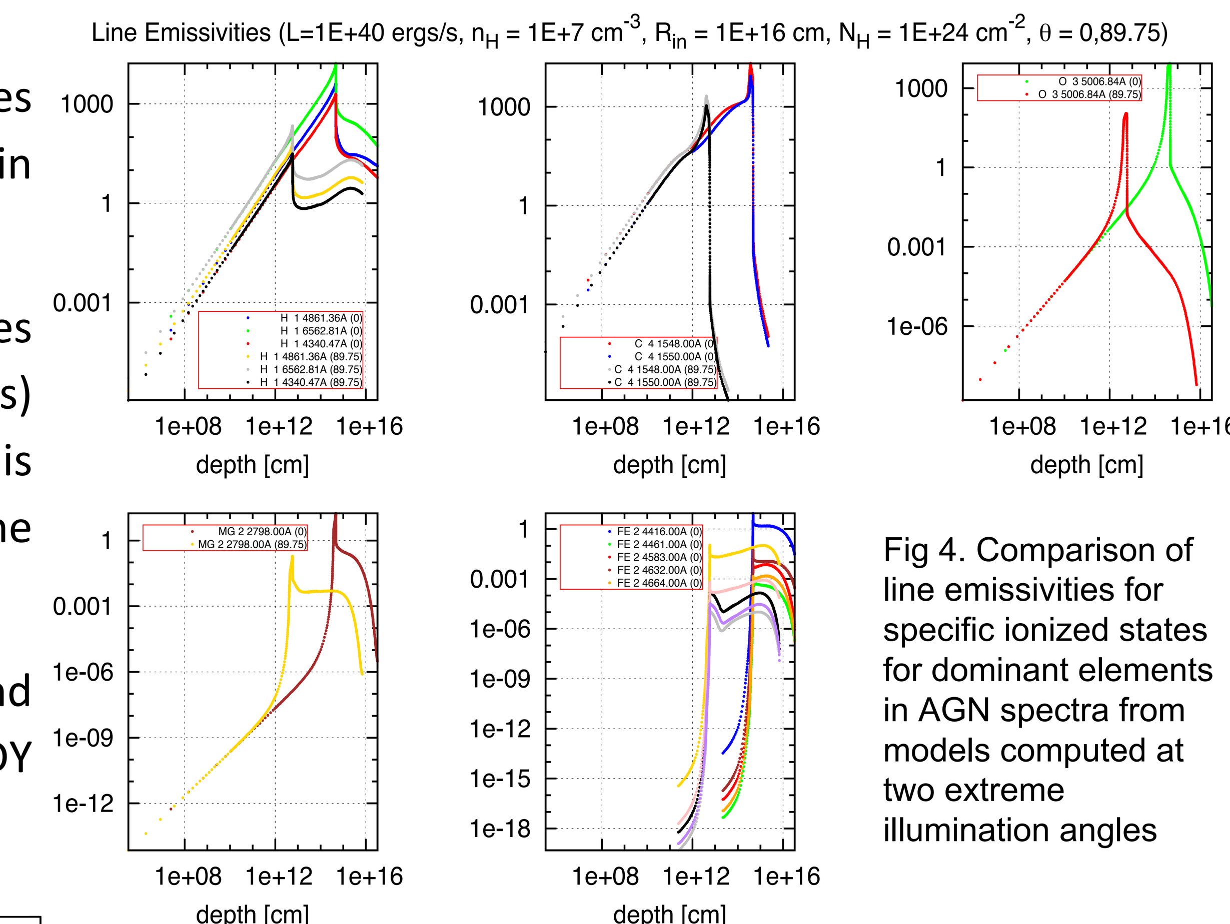


Fig 4. Comparison of line emissivities for specific ionized states for dominant elements in AGN spectra from models computed at two extreme illumination angles

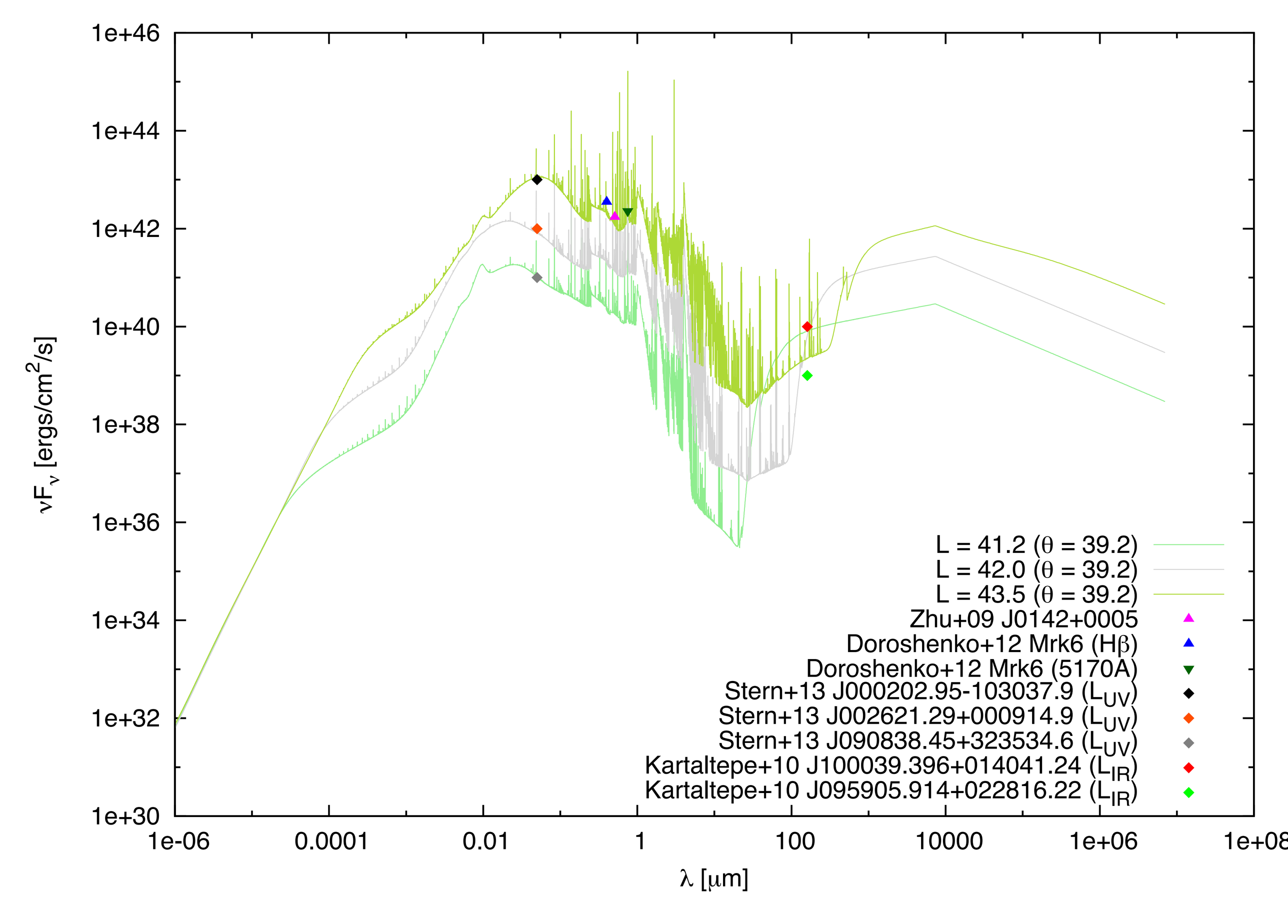


Fig 5. Observational data at different energies overplotted on different models with varying luminosities (log L = 41.2, 42, 43.5 ergs s^{-1}) at a specific inclination angle θ=39.2° according to Czerny+11

Results and Discussion

- "A certain diversion" - We bumped into a set (Zhu+09 "Analysis of broad-line regions in AGNs") of 90 AGN candidates with black hole masses (5.5 x 10^5 $M_\odot$ – 3 x 10^8 $M_\odot$) and continuum 5100 Å luminosities (1 x 10^{42} – 8.5 x 10^{44} erg s^{-1}).
- Using the relations from Czerny & Hrynewicz (2011), we calculated the disk temperature for these 90 objects (169 K – 2050 K). The average of the disk temperature we get 1110 ± 13 K, which agrees well with the_disk temperature values calculated in the paper (1030±61 K).