Start running hii.in with PDR

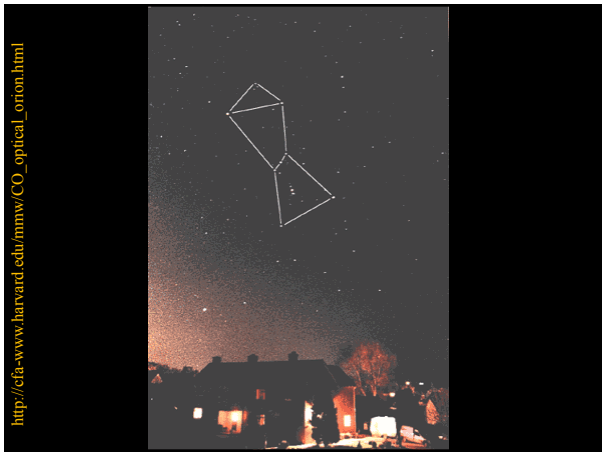
- **Extend into PDR**
  - stop temperature off
  - stop Av 10

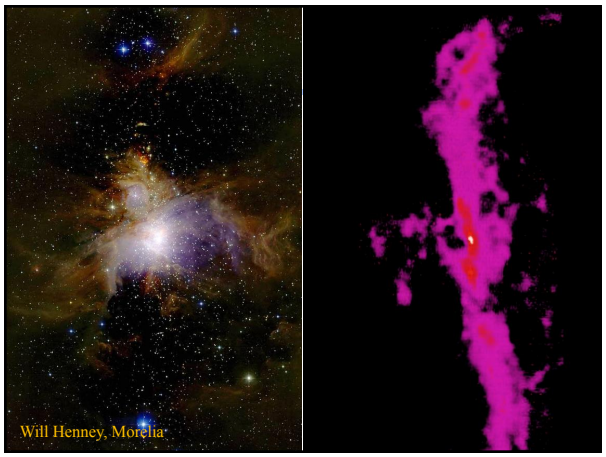
Intrinsic emission line spectrum

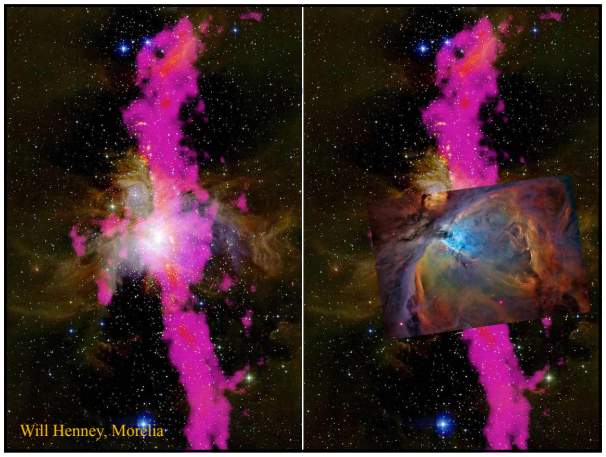
- **Line formation includes**
  - Continuum photo excitation (fluorescence)
  - Collisional excitation / deexcitation
  - Line trapping due to line optical depths
  - Line destruction due to "background opacity"
  - Background opacity includes continuum absorption / scattering such as
    - » Electron scattering
    - » Photoelectric absorption
    - » Grains
- **The intrinsic spectrum includes all this physics**

What about dusty regions?

- **The dust extinction across the H^+ region must be small**
  - The H^+ - H^0 ionization front occurs at optical depth unity at 912A
  - That optical depth is usually dominated by hydrogen photoelectric opacity
  - The dust optical depth at 912A is almost certainly << 1
  - The dust optical depth in the optical is ~10x smaller than that
- **Very high ionization parameters are an exception, discussed here**


http://cfa-www.harvard.edu/mmw/CO_optical_orion.html


Will Henney, Morelia


Will Henney, Morelia

Intrinsic, emitted spectra

- **Hazy 2, Section 2.10**

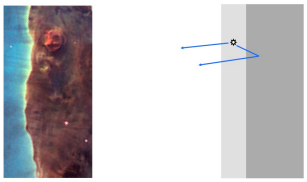


Figure 2.1: The geometry assumed in an open dusty geometry. The panel on the left is part of the HST image of M16, an H^+ layer on the surface of a molecular cloud viewed nearly edge-on. The idealized geometry is shown on the right. The lightly shaded area is the H^+ region, while the darker region to its right in the optically thick molecular cloud. Light produced by an atom in the H^+ region can directly escape from the illuminated face of the cloud. If the atom emits isotropically then roughly half the emission will escape this way. The remaining fraction of the light is emitted towards the molecular cloud where a small part, determined by the albedo, can be reflected back towards the illuminated face.

Emitted spectrum

- **Accounts for absorption and scattering *outside of the line formation region***
- **This is very geometry dependent and can model an H^+ layer on the face of a background molecular cloud**
  - Most H II regions have this geometry
- **For most geometries,, we recommend using the intrinsic spectrum and correcting for external reddening after the calculation**
- **Hazy2 Section 2.10**

Don't try to predict what the command parser does

- **It didn't evolve that way**
- **Check Hazy1**
- **Then check the output**
- **To see that it did what you wanted**

Main output – Hazy 2

Chapter 1

OUTPUT

1.1 Overview

This section defines the output produced by CLOUDY. Each section begins with a sample of the output described, and then goes on to describe the meaning of the printout in greater detail. The output actually shown is from the Orion H II Region / PDR / molecular cloud test case (orion_hii_pdr_pp.in).

1.2 Header Information

Several lines of output echo the input commands and outline some properties of the initial continuum.

```
                              Cloudy 06.01.02

**********************************06Jan02**********************************
*                                                                         *
* title the Orion HII Region / PDR / Molecular cloud with an open geometry *
* c                                                                       *
* c commands controlling continuum =========                              *
* c the incident continuum is two parts                                   *
```

Observed Quantities – Hazy 2

Chapter 2

OBSERVED QUANTITIES

2.1 Overview

This section describes how to convert the quantities actually used or predicted by CLOUDY into commonly observed ones.

2.2 Intensities of various continua

2.2.1 Incident radiation field

The incident radiation field is the light striking the cloud. The main printout printout gives the intensity of the incident radiation field with the label “Inci”. The total continuum [units erg s^{-1} or erg cm^{-2} s^{-1}] integrated over all energies is given with this label and a wavelength of 0. The incident radiation field is also evaluated at two wavelengths, 4860 Å and 1215 Å, as λF_λ or νF_ν, [units erg s^{-1} or erg cm^{-2} s^{-1}]

What are all those lines in the main output?

THE EMISSION LINES

9.1 Overview

The following sections outline the emission lines predicted by CLOUDY. Before version 90 of the code all lines were listed in the sub-section immediately following this section. The code is being modified to bring all lines into a common line class, as the code moves to C++ and objects. This chapter will remain incomplete until this work is finished.

9.2 The main emission-line printout

The main emission line printout was briefly described in the Chapter *OUTPUT*. This section goes into more detail.

Output organization. The printed list is sorted into four large groups of columns, with each large column sub-divided into four smaller sub-columns. The first sub-column is either the spectroscopic designation of the ion producing the line or an indication of how the line is formed. The second sub-column is the line wavelength, with a 0 to indicate a continuum. The third sub-column is the log of the power in the line, in the units given in the header (erg s^{-1} into either

Converging the optical depths

- **Iterate command, hazy 10.7**
- **Iterate to convergence**
- **Hazy 10.7.3 Convergence problems**
  - Trouble if outer edge of cloud changes between iterations
  - For instance, by lowest temperature
  - Set outer radius or column density

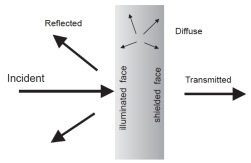


Figure 2.1: Several of the radiation fields that enter in the calculations.

Speed ups

- **Hazy 1, Sec 19.17**

Open source

- **Contributions welcome!**
- **Cloudy user group on Yahoo**
- **Code must be compatible with our license**
- **Also, use the Yahoo user group to ask any questions, or to report bugs**