Open source

- **Contributions welcome!**
- **Cloudy user group on [Yahoo](#)**
- **Code must be compatible with our license**

Don't try to predict what commands do

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

- ◆ **Review Hazy 1 description of any command you use**

The 2013 Cloudy Review

- **Ferland+ 2013 Rev Mex**

Review

THE 2013 RELEASE OF CLOUDY

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RESUMEN

Presentamos un resumen de la versión 2013 del código para simulación de plasmas Cloudy, el cual modela el estado térmico, químico, y de ionización de materia que puede estar expuesta a un campo de radiación externa u otras fuentes de calentamiento, y predice cantidades observables tales como los espectros de emisión

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                                             *
* c kurucz continuum and flux of photons striking cloud                             *
```

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}].

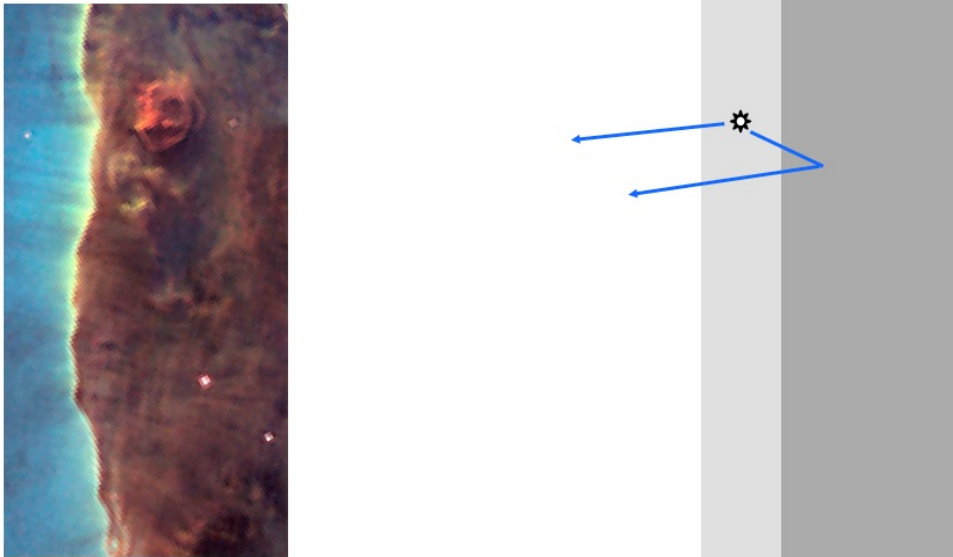# Intrinsic, emitted spectra

◆ **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.

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 4π sr or cm^{-2}). The last sub-column is the intensity of the line relative to the reference line

Species in Cloudy

◆ **Hazy 1 Sec 2.5**

2.5 "Species", how we specify atoms, ions, and molecules, and their spectra

2.5.1 Overview

CLOUDY simulates gas ranging from fully ionized to molecular. Nomenclature varies considerably between chemical, atomic, and plasma physics. We adopted a nomenclature that tries to find a middle ground between these different fields.

We refer to a particular atom, ion, or molecule as a "species". A species is a baryon. Examples are CO, H_2, H^+, and Fe^{22+}. Species are treated using a common approach, as much as possible.

Use the Cloudy yahoo group

- ◆ **https://groups.yahoo.com/neo/groups/ cloudy_simulations/info**

Air vs vacuum wavelengths

- **The rule in atomic physics had been to use vacuum wavelengths for $\lambda < 2000$ Å and air for $\lambda > 2000$ Å**

- **SDSS has used vacuum for all wavelengths**

- **Today's papers use a mix of both**

- **Vacuum is probably the future**

Reading in a predicted spectrum

- **Save transmitted continuum**
- **table read "func_trans_punch.trn"**
- **Tsuite / auto**
  - func_trans_save.in,   func_trans_read.in

Line profiles

- ◆ **Post process line & continuum output**

Velocity fields

- **Default is static, with thermal broadening**
- **Turbulence can be added**
  - makes line optical depths smaller, so lines escape more easily, continuum florescent excitation more important
- **Wind - ballistic supersonic outflows**
- **~sonic flows**
- **Line transfer with "Large Velocity Gradient" (LVG) or "Sobolev approximation"**
  - 2 names for same thing

Fine and coarse continuum grids

- **Shaw+ 2005**

MOLECULAR HYDROGEN IN STAR-FORMING REGIONS: IMPLEMENTATION OF ITS MICROPHYSICS IN CLOUDY

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ABSTRACT

Much of the baryonic matter in the universe is in the form of H_2, which includes most of the gas in Galactic and extragalactic interstellar clouds. Molecular hydrogen plays a significant role in establishing the thermal balance in many astrophysical environments and can be important as a spectral diagnostic of the gas. Modeling and interpretation of observations of such environments requires a quantitatively complete and accurate treatment of H_2. Using this microphysical [...] al astrophysical environments. This work forms th[...] nments in which H_2 is an important constituent.

Speed ups

- ◆ Hazy 1, Sec 19.17