1 PDRT: Photo Dissociation Region Toolbox

[1]

The package is called the Photo Dissociation Region Toolbox (PDRT) and seeks to aid astronomers in determining various physical properties of PDRs given observational data of the region.

[2]

I selected this package because it directly relates to my research interests in extragalactic astronomy, studying the interstellar medium. I have, minimally, used the package before, comparing its results to calculations I made myself, so I'm familiar with the physics which the package calls upon and its practical scientific applications.

[3]

PDRT was originally created in 2001 and has been continuously updated since, adding new features as demand grew and different observational methods became more prevalent in the field. The current stable version is 2.4.4, and is the version I used in the example.

[4]

The package is still maintained by the original authors Marc Pound and Mark Wolfire. In the documentation, they provide a link to the "GitHub Issue Tracker" where you can report any issues or suggested improvements to the package, as well as an online forum for asking questions and providing feedback.

[5][6]

The package was relatively easy to install and use. I simply pip installed to the Conda environment I wanted to use.

I will note that I was unable to get it to work on my Windows PC, but it worked easily using Linux. The documentation says that it should work with both, so this is likely due to having a cleaner python installation on the Linux machine, and nothing to do with the packages compatibility with the OS.

[7]

The source code for the latest release of the package is available to download from the public GitHub repository.

[8]

Looking through the citations, the package is not referenced by any other packages, only a number of papers using the package for its analysis, label.

[9]

The code can be ran with any traditional method of running python code, such as a python script or Jupyter notebook.

[10][12]

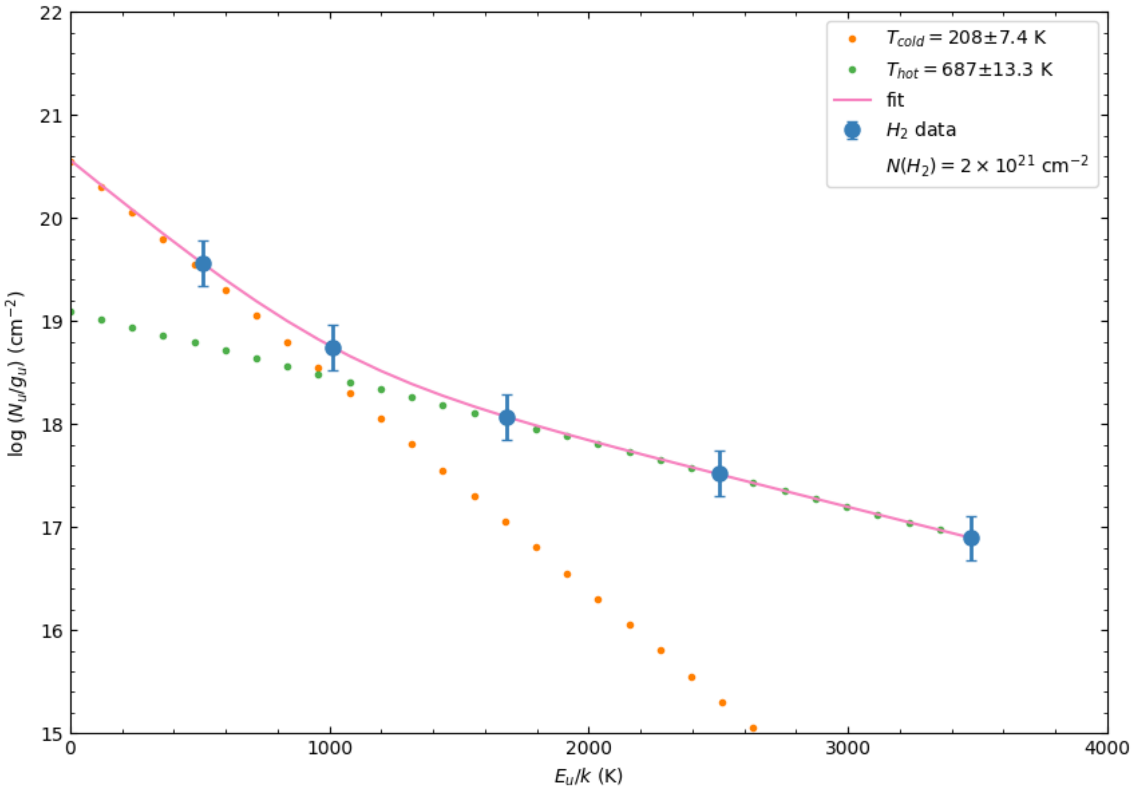

Figure 1: An H2 excitation diagram showing the normalized column-density vs. Energy for the S(0)-S(4) rotational lines of molecular hydrogen. The PDRT H2 Excitation analysis tool was used to fit the data (blue dots) to a 2 component temperature model. The results of the fit are displayed in the legend, and the individual components are plotted as green and orange dotted lines.

[11]

The package does produce figures with the built-in methods, through a dependence on matplotlib. In the example code provided, I used the ExcitationPlot().ex_diagram function, to plot the fit from the H2 Excitation Analysis Tool.

[13]

From the PDRTpy GitHub repository, the source code is 99.6% Python. There a single file (0.4%) that uses IDL to reformat some tabular data used in the code.

[14]

The package takes parameters or FITS files as inputs. The majority of the functionality of the package requires the instantiation of a Measurement object to define any observational data you want to work with. This can be done by manually inputting parameters such as intensity, uncertainty, and line identifier ("H200S1" for example, indicating an observation of the S(1) line of molecular hydrogen), or a FITS file from which the function will extract the line data automatically.

[15]

The outputs of the package are parameters and figures. There is a large collection of available models which you can use to analyze your observations (which you have inputted as Measurements). These models and your observations can be plotted, outputting a figure, and fitted, outputting the fitted parameters, such as gas temperature, density, and radiation-field strength.

[16][17]

The PDRT repository has an active CI system that ensures the packages functionality on Windows, Linux (Ubunto), and MacOS. Additionally, there is a set of test files that perform comprehensive unit tests on the code. Provided that you are running the most up-to-date, stable version of the package, these tests indicate that the package should be reliable and fully functional.

[18]

In the installation instructions section of the documentation, they specify that the package requires recent versions of numpy, scipy, astropy, lmfit, and matplotlib. Additionally, the GitHub repository has a requirements text file that lists emcee, corner, cycler, tqdm, pandas, and numdifftools.

[19]

There is a well-organized, comprehensive documentation page (`pdrtpy.readthedoc.io`) that gives an overview of the purpose of the package, installation instructions, and how to contribute and give feedback, as well as multiple modules that go into depth on the definitions, parameters, properties, and built-in methods for the different tools in the package.

Additionally, there are example Jupyter notebooks that show how to use key features of the package, including instantiating measurements, choosing models, and plotting and analyzing observations. The provided documentation made it very easy to learn how use the package.

[20][21]

The preferred method of citation is to cite 3 reference papers and the entry in the Source Code Astrophysics Library. The 3 papers are [1], [2], and [4], and the source code library entry is [3]. I did not use any additional references in this report.

[22]

The 2023 reference paper [4], alone, has over 30 citations from papers that use the toolbox for their analysis of PDRs. One paper, in particular, uses PDRT to analyze [CII] and [OI] lines and the FIR continuum detected in ALMA data: `https://ui.adsabs.harvard.edu/link_gateway/2025arXiv250407325R/doi:10.48550/arXiv.2504.07325`

[23]

The package does make extensive use of dictionaries, which we only briefly covered in class. The usage of dictionary keys is very useful as an identifier/label for parameter inputs and outputs, particularly, as used in my example code, labeling emission lines. Additionally, PDRT uses the astropy package for handling units, which is, again, something we only briefly covered in class. For the most part, however, the material we covered was sufficient for learning how to use the package.

[24]

As I mentioned previously, I do have experience with this package as part of my research with the Astronomy Department, where I've used the PDR Toolbox to analyze emissions from warm molecular gas.

References

[1] Michael J. Kaufman, Mark. G. Wolfire, and David J. Hollenbach. [Si II], [Fe II], [C II], and H_2 Emission from Massive Star-forming Regions. , 644(1):283–299, June 2006.

[2] M. W. Pound and M. G. Wolfire. The Photo Dissociation Region Toolbox. In R. W. Argyle, P. S. Bunclark, and J. R. Lewis, editors, *Astronomical Data Analysis Software and Systems XVII*, volume 394 of *Astronomical Society of the Pacific Conference Series*, page 654, August 2008.

[3] M. W. Pound and M. G. Wolfire. PDRT: Photo Dissociation Region Toolbox, February 2011.

[4] Marc W. Pound and Mark G. Wolfire. The PhotoDissociation Region Toolbox: Software and Models for Astrophysical Analysis. , 165(1):25, January 2023.