The Photodissociation Region Toolbox: Past & Future

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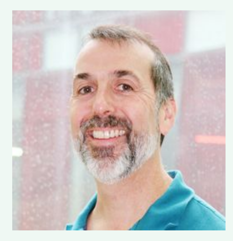


What is PDRT?

PDRT is science-enabling tool for the community, designed to help astronomers determine the physical parameters of photodissociation regions from observations. Users enter the flux and errors of their lines or continuum and PDRT finds the best-fit interstellar radiation field G_0 and hydrogen number density n using the models of Kauffman+ 1999, 2006. PDRT has a worldwide community who have benefitted from its use in their research and publications.

PDRT Statistics Since 2014	
Uses of PDRT	~245,000
Unique IP addresses	619
Countries	35
Citations to PDRT papers	670

History

Twenty years ago, when we started the Photodissociation Region Toolbox (PDRT), web programming meant Common Gateway Interface and Perl was King. Single pixel detectors were cutting edge technology and the sub-mm window had just begun to be explored. Airline travel was pleasant and people still smoked cigarettes. We put together PDRT with Perl, HTML, Apache 1.3, FITS files, CVS, shell scripts, thumb tacks, horsehair, and bits of string. The tool filled a need, scratched an itch, developed an international user base. As new telescopes arrived, we added spectral lines and low metallicity models. Web-free scripting interfaces were created by users. Our funding ran out, but we added lines when users requested and kept the service running. Single pixel detectors gave way to cameras and the sub-mm science matured. Recently, we received 3 years of funding to implement upgrades, described here. Let us know which are most important to you and what else you'd like to see!

Spectral Lines Modeled in PDRT

	Species	Wavelength	ALMA	Herschel	JWST	Spitzer	SOFIA	SWAS
Currently Available	[C I]	370μm, 609μm		•			•	•
	[C II]	158μm		•			•	
	[O I]	63μm, 145μm		•			•	
	[Fe II]†	26μm			•	•	•	
	[Si II]†	35μm			•	•	•	
	H_2 0-0S(0) to S(3)†	28.2–9.7μm			•	•	•	
	H_2 6-4Q(1)†	1.6μm			•			
	H_2 1-0S(1)†	2.12μm			•			
	^{12}CO J=1 to 7	2.6–0.4mm	•	•			•	
Proposed Additions	[^{13}C I]]‡	370μm, 609μm		•			•	•
	[^{13}C II]‡	158μm		•			•	
	H_2 S(4) to S(20)$^{\ddagger\,\S}$	8-1μm			•	•	•	
	^{12}CO J=8 to 25‡	0.3–0.1mm	•	•			•	
	^{13}CO J=1 to 25‡	2.6–0.1mm	•	•			•	
	^{12}CO v=1-0‡	4.5-5μm			•			
	H_2O v=1-0‡	6.7-7μm			•		•	
	[S I]‡	25.2 μm			•		•	
	[Fe II]‡	17.9 μm			•		•	
	[Fe I]‡	24.0 μm			•		•	
	[F I]‡	24.8μm			•		•	
	[Cl I]‡	11.3μm			•		•	

†metallicities Z=1,3 ‡metallicities Z=0.1,0.3,1,3,5

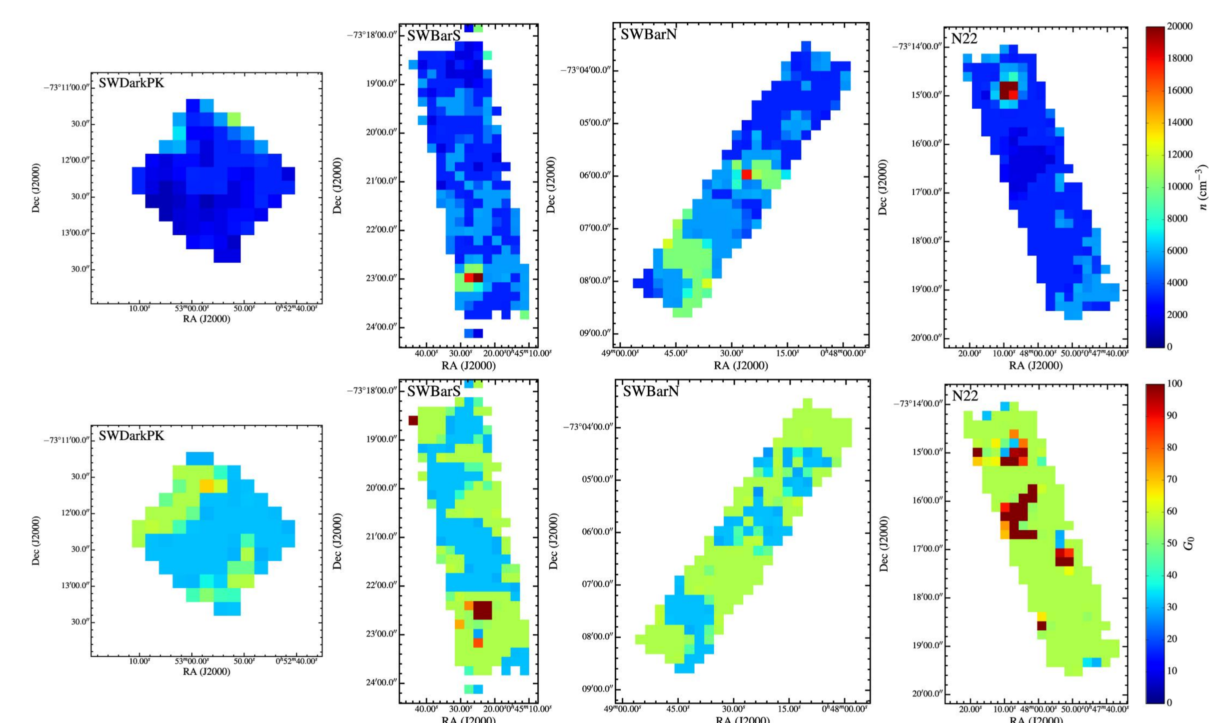
§pure rotational and rovibrational transitions v(0)-v(6)

Current and future spectral lines available in PDRT and the telescopes that can observe them. We will also cover a wider range of metallicities, from Z=0.1 to 5.

Upgrade Highlights

- More spectral lines and metallicities
- Support for map-based analysis.
- Improved physics and chemistry including:
  - molecular freeze-out
  - updated collision and chemical rates
  - new chemical pathways, e.g for oxygen chemistry
- Put power in users hands through Python notebooks and JupyterHub.
- Include beam convolution in model maps
- Enable user-initiated model runs
- Add constant pressure models

Example Mapping Conditions in the SMC

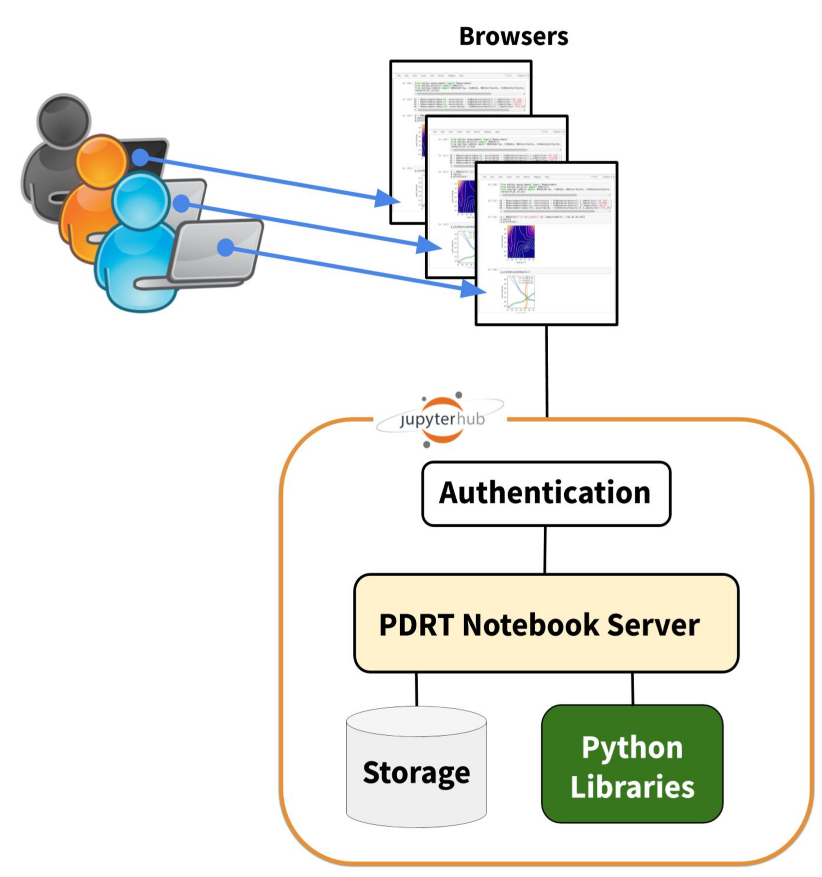


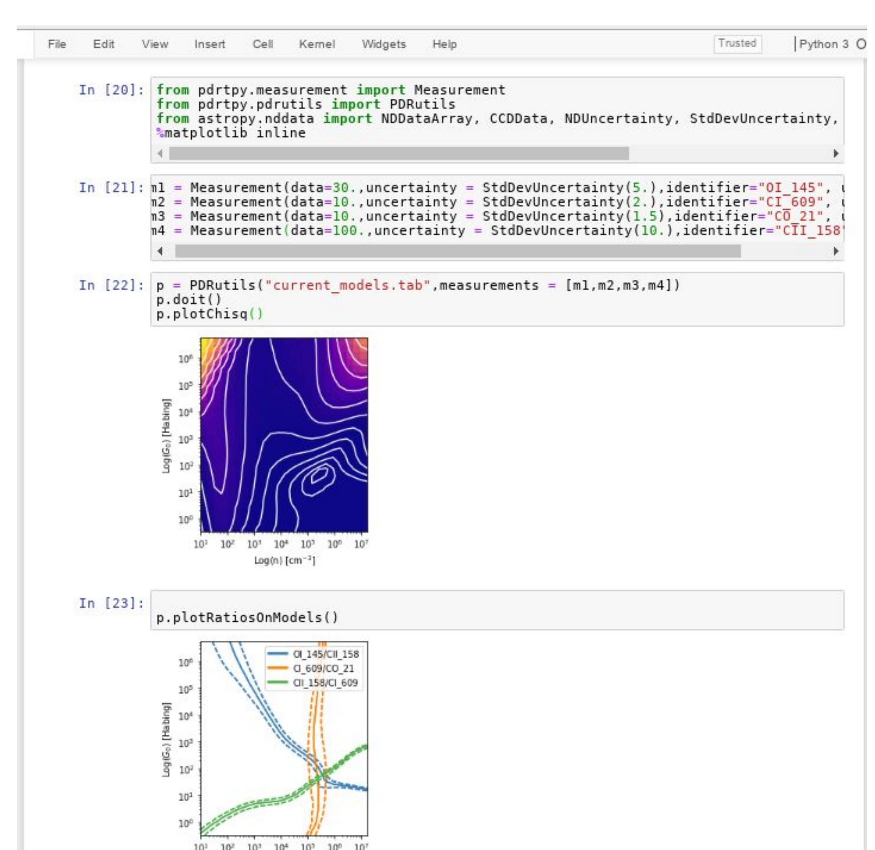
Density and radiation field in SMC star forming regions, created using PDRT to model the conditions in the SMC (abundances, cosmic-ray rates, dust-to-gas ratio). The top row shows volume density n. The bottom row shows FUV radiation field strength G_0 (Jameson et al 2018). Creating such maps will be routine with the upgraded PDRT.

We'll process archival PDR data for public analysis.

For instance, we will provide spatial maps of best-fit model parameters for the KINGFISH survey of 54 galaxies, which observed [C II] 158 μm, [O I] 63 μm, [N II], [O III] lines, and FIR continuum (Kennicutt+ 2011; Aniano+ 2012; Herrera+ 2015,2016,2017). These can be used to investigate for example, the gas physical conditions as a function of distance from star forming regions, conditions across arms from leading arm gas to trailing arm gas, and conditions in the disk as a function of distance from the nucleus.

Modern Technology for More Flexible Use





We will deploy PDRT as a Python notebook (prototype example on right). For standalone use, the notebook and PDRT Python library can be downloaded via github. For more advanced use, such as running new models, we will deploy a JupyterHub server that support multiple users (left).

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