agnpy: an open-source, do it yourself, approach to (jetted) AGN modelling

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AGNpy

Introduction

agnpy [1] is a python package modelling the radiative processes of relativistic particles accelerated in the jets of Active Galactic Nuclei (AGN). It additionally includes classes representing the AGN thermal and line emitters and computes the γ-γ absorption produced in their photon fields. The package is built on numpy [2] and astropy [3] and is affiliated with the latter project. [**GitHub**, **Docs**]

Package Modules

Emission Regions

agnpy.emission_regions describes the region responsible for particle acceleration and radiation. It contains an $e^{\pm}$ energy distribution parametrised with an analytical function.

Radiative Processes

A module is dedicated to each radiative process:

- agnpy.synchrotron for synchrotron radiation (with self-absorption), implemented following [4];
- agnpy.compton including both synchrotron self-Compton (SSC) and external Compton (EC) on the line and thermal emitters photon fields, implemented following [4] and [5];
- agnpy.absorption computing γ-γ absorption on the line and thermal emitters photon fields, implemented following [5].

Thermal / Line Emitters

The line and thermal emitters gathered in agnpy.targtes are:

- the Cosmic Microwave Background (CMB);
- a monochromatic point-like source behind the jet ;
- a Shakura-Sunyaev disk;
- an infinitesimally thin spherical broad line region (BLR);
- a ring dust torus (DT).

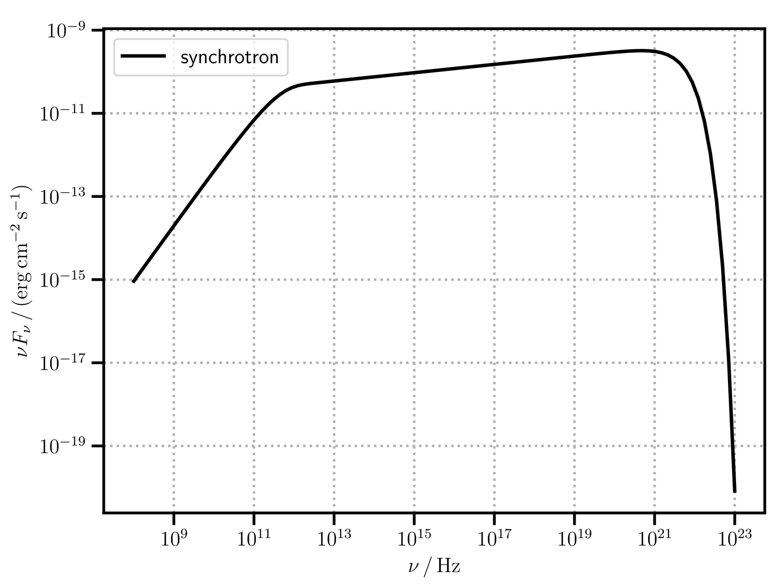
They can be used as target for EC or γ-γ absorption; their broad-band emission can also be evaluated.

Examples

Compute the SED for a Given Radiative Process

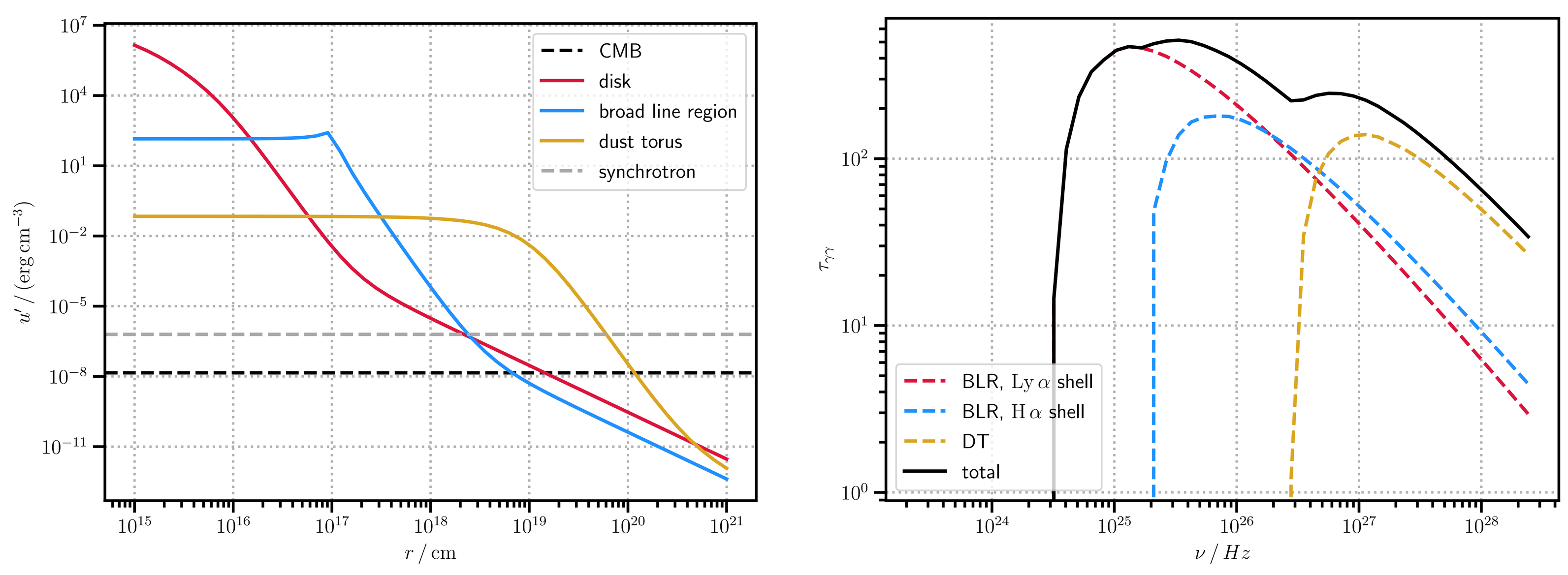
With few lines of python the user can evaluate the SED for a specific radiative process

```
import numpy as np
import astropy.units as u
from agnpy.emission_regions import Blob
from agnpy.synchrotron import Synchrotron
from agnpy.utils.plot import plot_sed
import matplotlib.pyplot as plt
# define the emission region and the radiative process
blob = Blob()
synch = Synchrotron(blob)
# compute the SED over an array of frequencies
nu = np.logspace(8, 23) * u.Hz
sed = synch.sed_flux(nu)
# plot it
plot_sed(nu, sed, label="synchrotron")
plt.show()
```



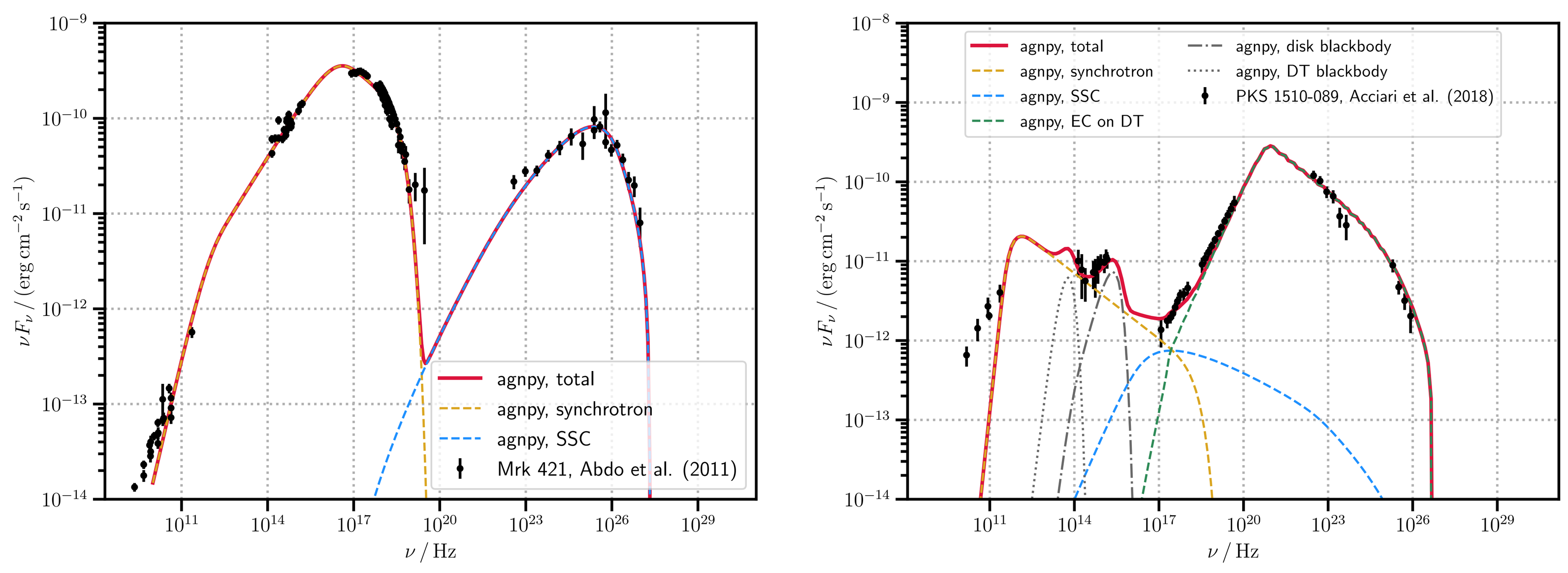
Evaluate Energy Density and Absorption of the Line and Thermal Emitters

agnpy allows to evaluate the energy density, $u/(\mathrm{erg\,cm^{-3}})$, of the line and thermal emitters as a function of the distance from the jet axis r; or their γ-γ opacity, $\tau_{\gamma\gamma}$, as a function of the escaping γ energy.



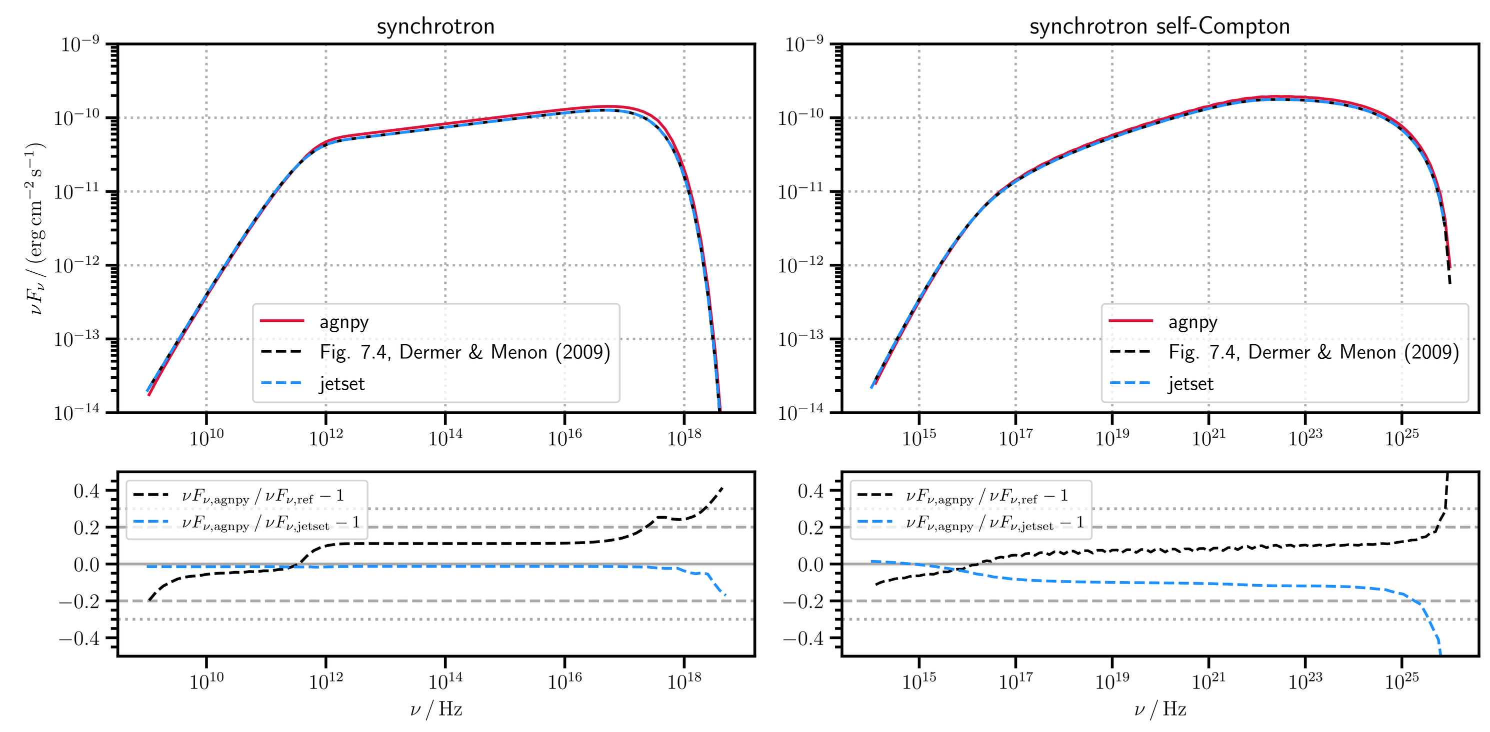
Fit a MWL SED

agnpy can be wrapped by any python-based data-analysis tools. In the documentation we show how to create a wrapper with sherpa to fit the SED of Mrk421 and PKS1510-089.



Validation

agnpy is thoroughly validated against bibliographic references and against other modelling codes relying on the same physical assumptions. An agreement between 10% and 30% with other sources is achieved. Below we compare agnpy's synchrotron and SSC spectra against the ones in [4] and the ones produced with jetset.



References

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