MIST_assignment

August 16, 2024

1 How to get started

This assignment will use Google Colab to let you work with Python code in your browser, without needing to install anything on your own computer. But you will need to configure the files in your Google Drive for everything to work. In order to set things up, please see the instructions below:

0. Follow this link to open a read-only copy of the assignment notebook in Google Colab: https://colab.research.google.com/drive/1WGAsxKwaAEfuhjtkKEOnZ496LoF0QOCQ
1. Make a copy of the Colab Notebook in your Google Drive. In the top left, go to "File", then select "Save a copy in Google Drive". Then, go to your copy so you can edit it and save your changes.
2. Unzip the nanospace_school.zip folder you recieved. Upload the unzipped folder into the top directory of your Google Drive, and make sure the folder is named nanospace_school, with all of the correct files inside (data folder, spectra.json, mist.py, etc.). You should have the folder structure: "MyDrive/nanospace_school/". This step is very important!
3. Run the first block of code below, which will give the Colab Notebook access to your Google Drive, and then change the running directory to be inside the nanospace_school folder. This is how the rest of the notebook will be able to access the necessary files. If prompted, log-in to the same Google account you used to access your Google Drive. If asked, allow full access.
4. **When changing the configuration file later in the assignment**, you can open it in this notebook by clicking the folder icon on the left side bar and searching for the file in your google drive folder. Any changes will be autosaved. Then, you will be able to run the notebook and amend the configuration file in real time.

[ ]:
```
# gives the colab notebook access to your google drive
from google.colab import drive
drive.mount('/content/drive')

# sets the working directory to the folder with the data
%cd '/content/drive/MyDrive/nanospace_school'
```

2 NanoSpace School 2024 Assignment

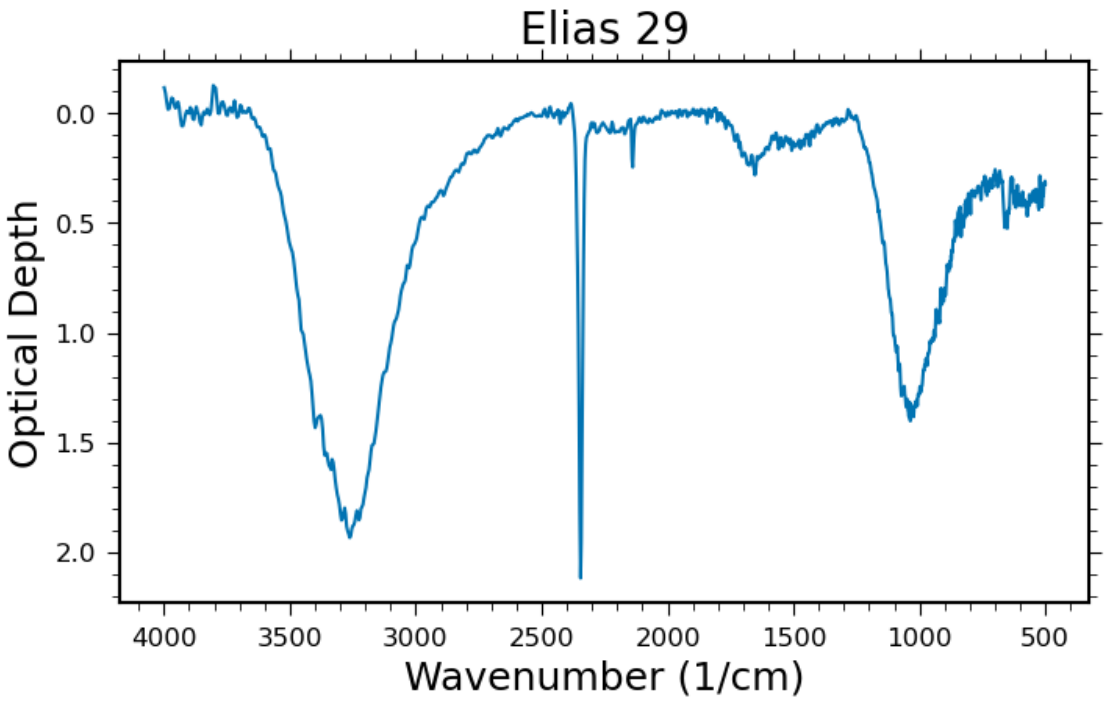
2.1 Infrared Observations of ices towards the low mass protostar Elias 29

Background: The purpose of this exercise is to use laboratory data available online at the LIDA ice database to estimate the column density (abundance) of ice species toward the low mass protostar Elias 29 as observed in the infrared spectral range by the ISO Short Wavelength Spectrometer (ISO–SWS; de Graauw et al. 1996). Observational data has been published by Boogert et al. (2000) and are available as an ascii file under the name `Elias29.dat` in the folder `./data/observational/`

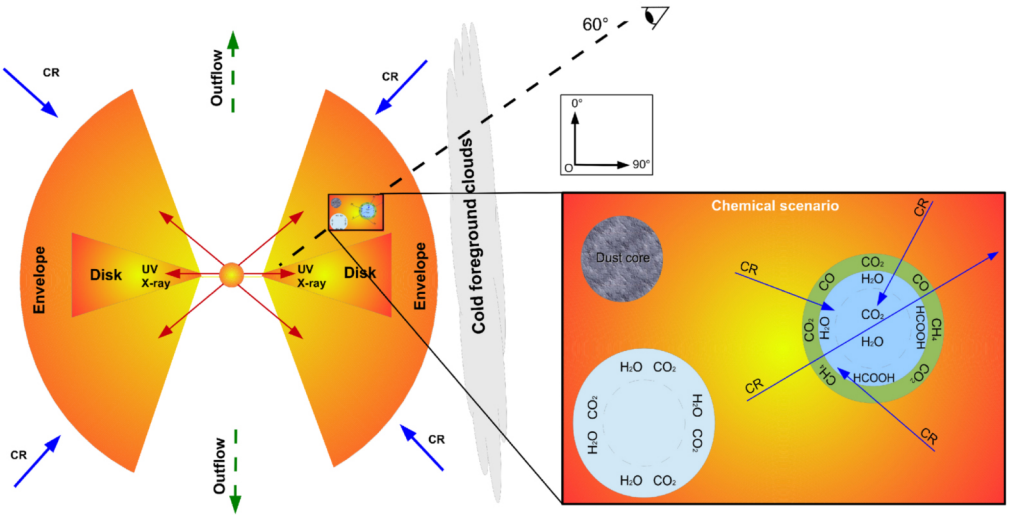
A plot of the data is shown below:

[16]:
```
from tools import plot_elias29
plot_elias29()
```

[16]:



Part 0: Find relevant info about Elias 29 in literature and describe the type of source. Start from the papers included in the shared folder Based on Figure 6 from Rocha & Pilling (2015), discuss the ice material visible along the line of sight toward the source paying attention to some key physicochemical parameters and their effect on ices (e.g., temperature and radiation).



[ ]:

Part 1: Fit the observed data with lab spectra using MIST, as described above and plot them. The `spectra.json` file is already configured for you with several laboratory spectra from the LIDA ice database which you can use. Use the LIDA website to guide your selection of lab spectra by clicking on the data and then clicking on "inspect spectra." Find spectra which seem to be a good match with the observational data. Then, find each spectrum you want to fit with in the configuration .json file and set its `weight` parameter to some non-zero value, which you think would make for a good fit.

If you find a spectrum in the LIDA database you want to try using, but is not in the `spectra.json` file already, download the data from LIDA to the `./data/laboratory` and make a new entry in the `spectra.json` file to match it, following the same format as the files already there. Then you should be able to use it in your fit.

For Part 1, use only simple, cold, pure ice components (i.e., spectra of small, inorganic molecules deposited pure (i.e., not in mixtures) at 10-15 K).

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Part 2: Discuss your results obtained in Part 1. Make a table of your ice components and their column densities and add a column with the corresponding abundances from literature for the same source (after fitting with MIST, fitted column densities are stored in the `.results` attribute, as shown in the last of the examples above).

Compare your results with literature. Explain why your synthetic spectrum is not able to match well with observations in the spectral ranges between 3.2 and 3.9 m (water ice red wing), 5.5 and 7.5 m, and 14.6 and 16 m (CO 2 bending mode band). Find help in literature.

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Part 3: Now move one step forward and generate a fit to the SED of Elias 29 by adding more spectral components of the same species already used, but at different temperatures and different mixing ratios with each other. Make a plot. Comment on whether your fit to the observations

improved. Finally, add other ice components that were not previously included, such as COMs. Does this help the fit? Discuss it.

Make a new table including all your fit components and their parameters and compare to literature. Have you discovered something "new", potentially interesting, in the data? In the early 2000s, spectra of COMs were not available. You may be the first one looking into this now. Discuss your results and conclusions in view of the physicochemical conditions depicted in the figure shown on Part 0.

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