ezRA - Easy Radio Astronomy - Introduction

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The ezRA Easy Radio Astronomy set of programs are free PC tools to help explore Radio Astronomy. The programs run on the Python3 programming language, on Windows and Linux.

There are 5 major ezRA programs:

ezCol - COLlect radio signals into integrated frequency spectrum ezRA .txt data files.

Or convert previous radio data with ezColBaa, ezColHay, ezColIFAvg, ezColSc, etc.

ezFix – remove unwanted samples from, combine, edit, and split frequency spectrum ezRA .txt data files.

ezCon - CONdense one or more frequency spectrum data .txt files into one .ezb text data file, and perhaps one Galaxy crossing spectra *Gal.npz data file.

ezPlot - PLOT analysis from one or more .ezb condensed data files.

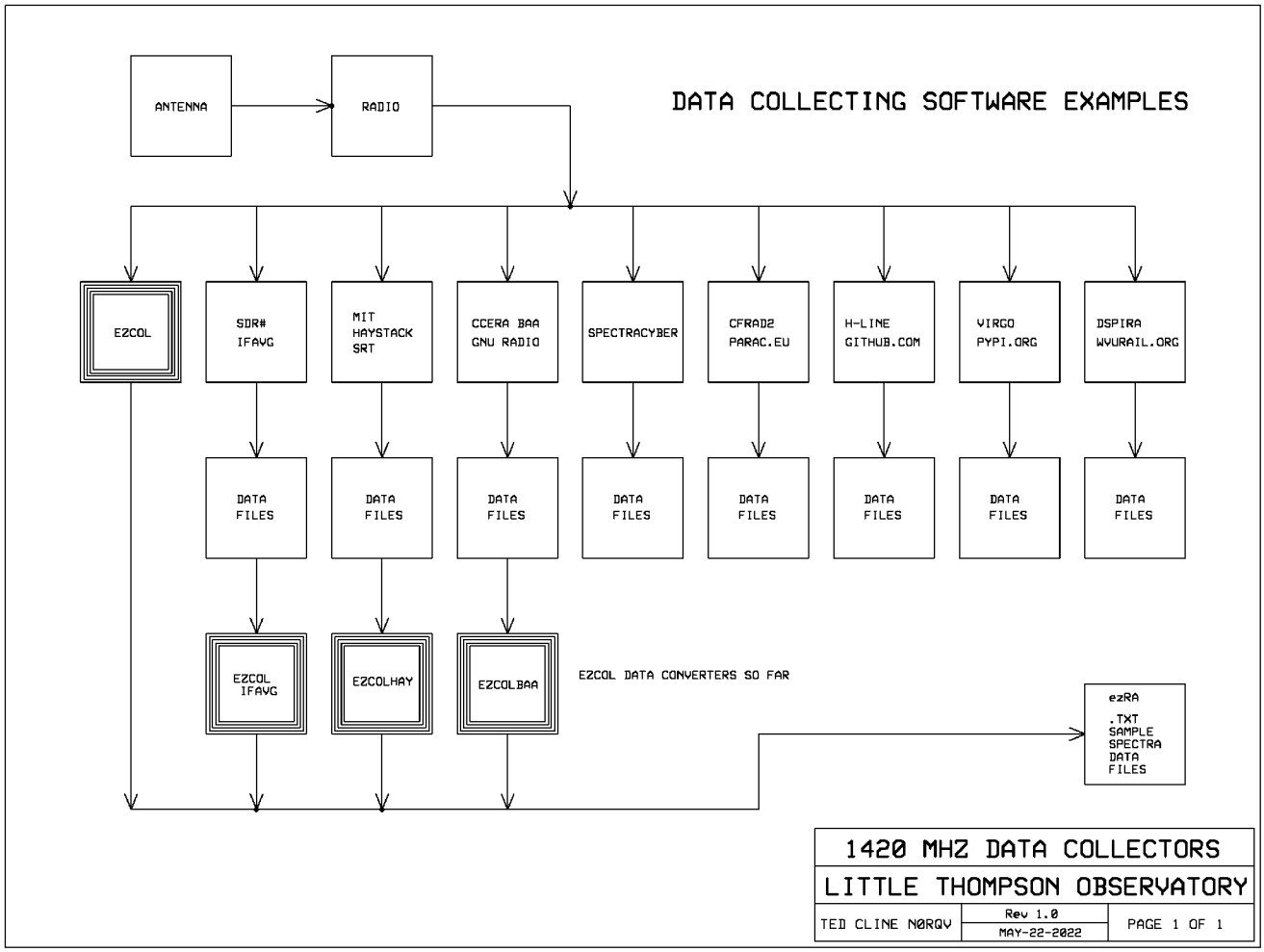
ezSky - SKY maps from one or more .ezb condensed data files.

ezGal - GALaxy plots from one or more spectra *Gal.npz data files (Galaxy rotation, Velocity vs Galactic Longitude, Galaxy arm plots?).

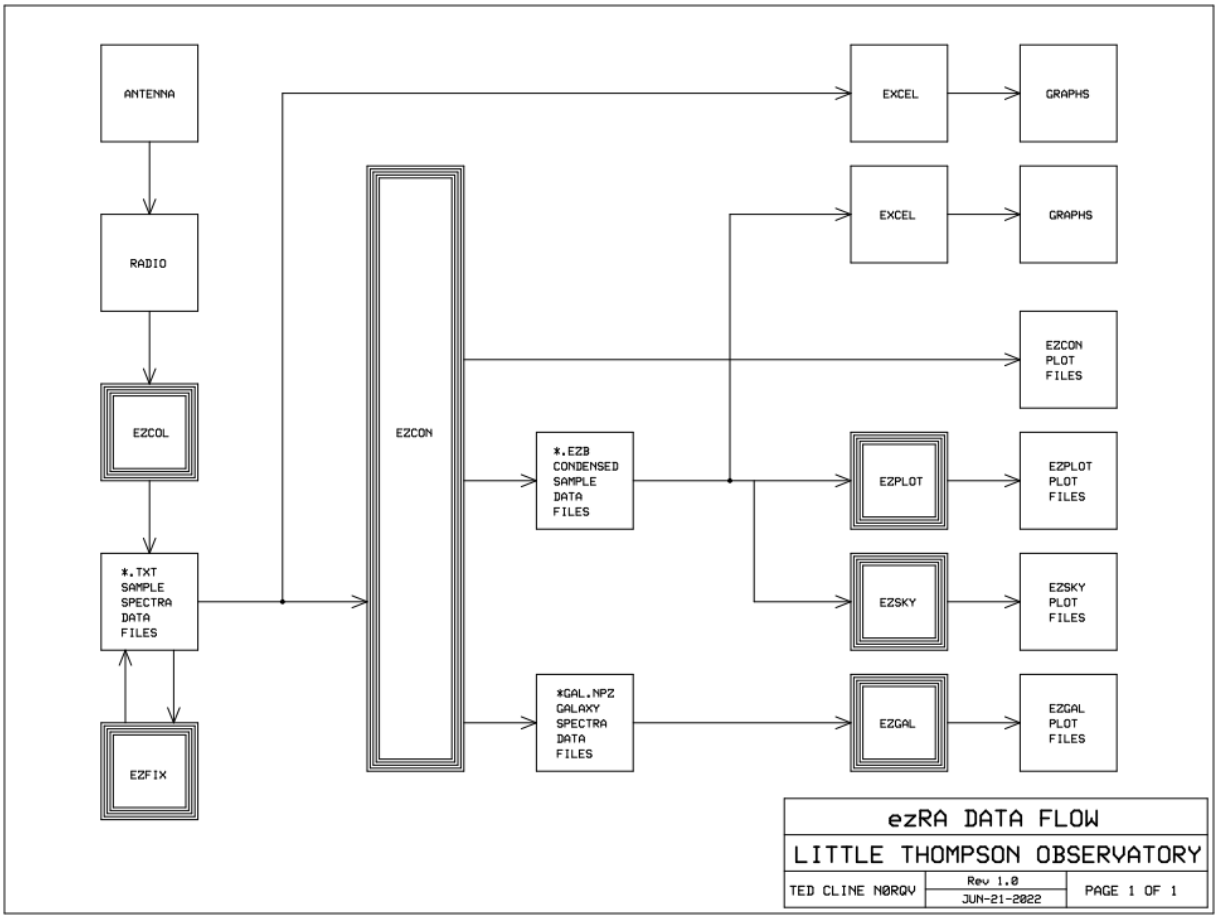
First, a brief system overview.

A Radio Astronomy antenna receives a signal from the sky, and a computer system collects and records the signal into data files. There are many choices of frequency, reflectors, antennas, polarization, amplifiers, filters, cable, power methods, receivers, bandwidths, precision, integration, temperature stabilization, frequency stabilization, etc.

And there are many choices of drift-scan data collecting software. For 1420 MHz, there is ezCol, SDR# with an IF Average plugin, MIT Haystack SRT, CCERA BAA GNU Radio, SpectraCyber, CFRAD2, H-Line, Virgo, DSPIRA, and others. All their data file formats can be converted into ezRA frequency spectrum .txt data files. The ezCol program's data files need no conversion.



Once in the proper format, the data files can be edited and analyzed with the ezRA programs.



Documentation for ezRA will eventually include:

README.txt

ezRA_00_Introduction.pdf
ezRA_01_Tour.pdf

ezRA_05_Demonstration.pdf

ezRA_10_Hardware_1.pdf
ezRA_11_Hardware_2.pdf

ezRA_20a_Software.pdf
ezRA_20b_Software_Installation_Windows.pdf
ezRA_20c_Software_Installation_Linux.pdf

ezRA_21a_ezCol.pdf
- ezRA_21d_ezColBAA.pdf
- ezRA_21c_ezColHay.pdf
- ezRA_21b_ezColIFAvg.pdf
- ezRA_21e_ezColSC.pdf
- ezRA_21y_ezRename.pdf
- ezRA_21z_ezFix.pdf

ezRA_22_ezCon.pdf
ezRA_23_ezPlot.pdf
ezRA_24_ezSky.pdf
ezRA_25_ezGal.pdf

Notes:

ezRA documentation assumes your antenna is stationary on the earth's northern hemisphere.

"Galactic hydrogen emission" usually refers to radio waves from hydrogen gas in _our_ nearby Milky Way Galaxy. The Andromedia galaxy is too far away for us amateurs to explore.

ezRA is short for Easy Radio Astronomy.
ezRA is pronounced "EZZ-rahh".
Ezra is an ancient word meaning "help" or "aid".

ezRA strives to be a teaching tool.

Started in 1951, this 1420 MHz exploration continues today, using space satellites.

Comments

OK, let's go over some of the above again, but slower.

There are 5 major ezRA programs.
The programs are written in the Python3 programming language, so the program file names all end with ".py".
The ezRA_01_Demonstration.pdf file shows how to start using the programs.

ezCol - COLlects the weak radio signals and records that data into computer files.
Those data files are human-readable files, with names ending with ".txt".
The .txt files may be big, but you can explore them with a text editor.
The .txt files may also be explored with a spreadsheet program, like Excel or LibreOffice Calc.

The ezRA .txt data files record the radio data in "samples".
Each sample is on one long text line, and starts with a date and time "timestamp", followed by many values, each separated by a space character.
The number of values is some multiple of 2, like 256 or 2048.
Each value is a measure of radio power received at a particular frequency.
Each value is the power of a frequency channel, a frequency bucket, a frequency bin, a "freqBin".
The many values start with the lowest frequency, and end with the highest frequency.
So, each sample is mostly a long list of power values for a spectrum of frequencies.
Usually the center of a sample's frequencies is 1420.405 MHz.
And each ezRA .txt data file starts with the antenna's name and earth location, where it is pointing, and the minimum and maximum frequencies.

So, ezCol directly writes radio signals into ezRA .txt data files.

But maybe you have already collected radio data using some other program, like
   MIT Haystack SRT (into .rad data files)
      https://www.haystack.mit.edu/haystack-public-outreach/srt-the-small-radio-telescope-for-education
   SDR# and IF Average PlugIn (into one .txt data file per sample)
      https://www.rtl-sdr.com/cheap-and-easy-hydrogen-line-radio-astronomy-with-a-rtl-sdr-wifi-parabolic-grid-dish-lna-and-sdrsharp/
   SpectraCyber (into one text data file per sample)
      https://www.radioastronomysupplies.com
   British Astronomical Association with CCERA and Gnu Radio (into .csv data files)
      https://www.youtube.com/watch?v=_3vkEIYs7gk&ab_channel=britishastronomical
If so, then those data files need to be converted into ezRA .txt data files with ezColHay, ezColIFAvg, ezColSc, or ezColBaa programs (those programs have not been tested recently).

OK, now you have some ezRA .txt data files.

Maybe you will need the ezFix program to remove unwanted samples from, combine, edit, and split those ezRA .txt data files.
Go read the ezRA_21z_ezFix.pdf file (if it exists).

But that radio signal may be weak.
The ezCon program can help reveal the weak Galactic hydrogen information.
ezCon CONdenses that information into smaller .ezb and .npz data files.
The following programs use those smaller .ezb and .npz data files.
The .ezb files may be big, but you can explore them with a text editor.
The .ezb files may also be explored with a spreadsheet program, like Excel or LibreOffice Calc.

Maybe there are problems in the collected data.
Strong transmitters (local or distant) may pollute the data.
The telescope's location, or the date and time in the timestamps, may be wrong.

The phrase, "garbage in, garbage out", means the quality of the output plots depends on the quality of the input data.
The ezPlot program PLOTs .ezb condensed data files in many ways, to allow detection of bad data.
Do the plots match what is expected ?

The ezSky program plots the radio SKY in several ways.
Do the plots match what is expected ?
Can your telescope see the whole radio sky ?

The ezGal program studies the data collected from the plane of our Milky Way Galaxy.
How fast does the Galaxy rotate ?
Are there different rotation speeds for different distances from the Galactic center ?
Why ?
Does the curve agree with Newtonian physics ?
Can we plot the locations of the Galaxy arms ?

The ezRA policy is to create many plots. Some plots may not always be useful.
Can you explain the data in the plots ? Any surprises ?
Explaining the data in the plots drives exploration, understanding, and learning.

ezRA strives to be a teaching tool.