

eht-imaging Roadmap

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Contents

1	Introduction	2
1.1	Related links	2
2	Installation	2
3	eht-imaging tutorial/documentation	2
3.1	Documentation	2
3.2	Some ways to learn to use the code	2
4	Some publications that use ehtim	3
4.1	The Size, Shape, and Scattering of Sagittarius A* at 86 GHz: First VLBI with ALMA, Issaoun et al. 2019	3

Python modules for simulating and manipulating VLBI data and producing images with regularized maximum likelihood methods by [Andrew Chael](#) from CfA of Harvard.

1 Introduction

ehtim (eht-imaging) is a Imaging, analysis, and simulation software for radio interferometry.

1.1 Related links

<https://achael.github.io/>

<https://github.com/achael/eht-imaging>
documentation

第一张黑洞照片全靠VLBI，这个Github项目教你用Python实现。

2 Installation

Download the latest version from the GitHub repository, change to the main directory and run:

```
sudo pip3 install .
```

If you want to use fast fourier transforms, you will also need to separately install NFFT and its pynfft wrapper. The simplest way is to use conda to install both:

```
conda install -c conda-forge pynfft
```

{conda is not installed on my computer, so I go to [Anaconda 镜像使用帮助](#) and install the miniconda3 from [this link](#) by downloading and executing the Miniconda3-4.7.10-Linux-x86_64.sh file.}

3 eht-imaging tutorial/documentation

3.1 Documentation

[documentation](#)

3.2 Some ways to learn to use the code

1. Start with the script examples/example.py, which contains a series of sample commands to load an image and array, generate data, and produce an image with various imaging algorithms.

After I run the example.py, there are some errors:

```

$ python3 example.py
Warning: No NFFT installed! Cannot use nfft functions
Warning: No NFFT installed!
Warning: No NFFT installed! Cannot use nfft functions
Warning: No NFFT installed! Cannot use nfft functions
Welcome to eht-imaging! v 1.1.1
Loading text image: ../models/avery_sgra_eofn.txt
Generating empty observation file . . .
WARNING: failed to download http://maia.usno.navy.mil/ser7/finals2000A.all and http://toshi.nofs.navy.mil/ser7/finals2000A.all, using local IERS-
B: <urlopen error [Errno -3] Temporary failure in name resolution>;<urlopen error [Errno -3] Temporary failure in name resolution> [astropy.utils
.iers.iers]

```

(The command of conda install seems to be not working) So first I need to install: **NFFT** and its **pynfft wrapper**

- The NFFT:
depends on the **FFTW** library, So I run: `sudo apt-get install fftw-dev`
`git clone https://github.com/NFFT/nfft.git`
- pyfftw:
`sudo pip3 install pyfftw`

2. **Slides**(**not available anymore, but I found it here**) from the EHT2016 data generation and imaging workshop contain a tutorial on generating data with the vlbi imaging **VLBI Reconstruction Dataset website**, loading into the library, and producing an image. Note that this presentation used a previous version of the code – some function names and prefixes may need to be updated.

4 Some publications that use ehtim

4.1 The Size, Shape, and Scattering of Sagittarius A* at 86 GHz: First VLBI with ALMA, **Issaoun et al. 2019**

We employ the eht-imaging library, a regularized maximum likelihood imaging software package, to image our sources (Chael et al. 2016, 2018b).

Due to the elevated noise level for the VLBA in our observations and the scattering properties of Sagittarius A*, standard imaging software packages like AIPS (Greisen 2003) or Difmap (Shepherd et al. 1995) do not offer the flexibility and necessary tools to obtain an unscattered image of the source.

The eht-imaging library is a Python based software package that is easily scriptable, flexible and modular.

It is able to make images with various data products (closure phase and amplitude, bispectra, visibilities), and it contains a suite of image “regularizers” such as maximum entropy and sparsity regularization. The library also possesses a routine for “stochastic optics”, a regularized implementation of scattering mitigation presented in Johnson (2016), making it a natural choice for our analysis. In this section we present our imaging methods for both calibrators (Section 4.1) and for Sgr A (Section 4.2).