The Condor Array Telescope:

An astronomical telescope for research, education, and public outreach

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Project Overview

Introduction

The Condor Array Telescope is an array telescope used for research, public outreach, and education located in the Rio Hurtado Valley of Chile. The telescope is conceived, built, and operated by a project team consisting of faculty and students based in the Department of Physics and Astronomy of Stony Brook University, and funded by the Advanced Technologies and Instrumentation program of the National Science Foundation.

Research Objective

- With the ultra-low-brightness sensitivity of the array, we can study the outer regions of the Milky Way, the Large and Small Magellanic Clouds, and nearby distant galaxies. By accurately modeling the PSF out to and beyond 1 degree, and using the PSF to model all stars within a given field of view, we can exploit deep images such that light from all stars in the field can be accounted for.
- Using the rapid-cadence of the array we can search and observe Earth-like planets within the habitable zones of white dwarf stars. As the size of a white dwarf star is roughly that of Earth, the transiting time duration of earth-like exoplanets is ≈ 2 mins which is very difficult to observe with current technology. However, the array is expected to reach a very rapid cadence of roughly 60s allowing for the possible observation of atmospheric spectroscopic signatures.

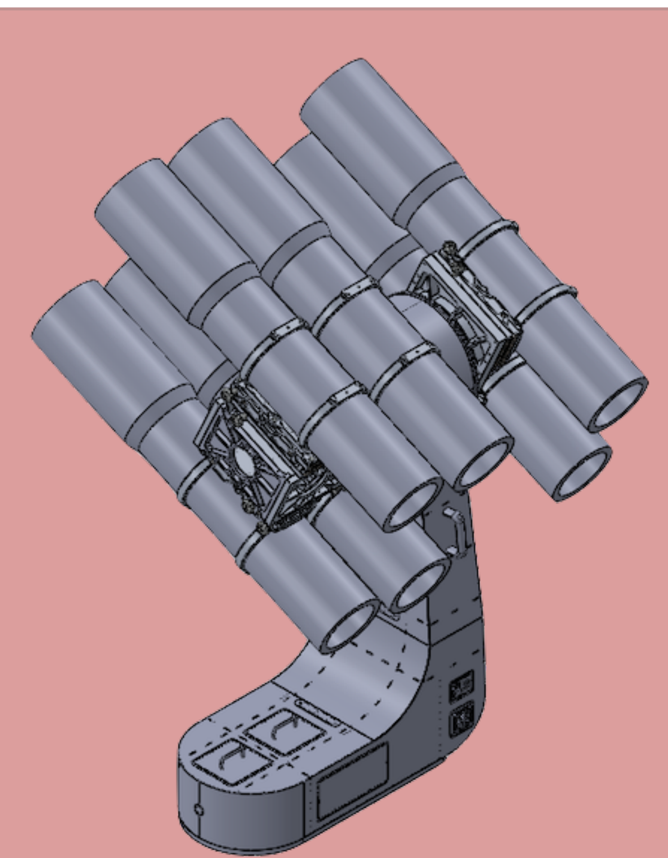
Telescope Configuration

Below are the components used for the construction of the array

- (6) TEC 180 mm-diameter apochromatic refracting telescopes
- Astro-Physics 0.72x quad telecompressor correctors
- ZWO EFW-7x2" motorized filter wheels
- Optec TCF-Leo motorized focusers
- Optical baffles coated with Nano-Lab carbon nanotube paint
- ZWO ASI6200MM large-format cooled CMOS cameras
- Selection of Sloan and LRGB filters
- PlaneWave L-600 direct-drive mount

Telescope Performance

- Sensor format: 9576 x 6388 pixel^2
- Instantaneous field of view: 2.3 x 1.5 deg^2
- Read noise: 1.1 to 3.5 e$^-$
- Maximum full-resolution frame rate: 3.2fps
- Plate scale: 0.86 arctic pixel^{-1}
- ADC bits: 16
- Maximum full-well capacity 51ke$^-$
- Peak quantum efficiency: 80%



Pictured to the Left: PlaneWave L-600 Direct-Drive Mount Configured with (6) TEC 180mm Telescopes

Current Development and Advancements

Our Website

The Condor Array Telescope aims to be managed and run through our very own website at "condorarraytelescope.org". This website will present many aspects of the project, including weather data, a project blog, images and videos from the telescope, and observation schedules. Using Python, HTML, JavaScript, and the free-to-use Python web development package "Django", I have managed to create videos using images, query select databases, and help build the website in general. Using this information, we have been able to provide videos of the past 24 hours through the telescope, as well as weather and tracking data from our hosting facility in Chile.

The website also has the ability for anyone to make an account to view observations and also if they have observing "credits" allocated to their accounts the ability to add an on observation will be available. Our teams scheduling software will then add the observation and optimize the scheduling sequence such that the most efficient order observations occurs.

- **(Group member responsible for above writing and development: Zachary Stone)**

Image Processing Pipeline

The pipeline is a semi automated process that will allow the user to convert raw images into data that allows for the identification and cataloging of different celestial bodies. The pipeline is currently using the LSST software stack as a base and guideline. The next step for the task will be to create and adapt a software package that will allow for a seamless integration with the LSST pipeline software to process the raw images taken from the Condor Array Telescope and eventually developing and tailoring a software package specifically for our use.

- **(Group member responsible for above writing and development: Eric Chen)**

Sky Analysis and PSF

We are currently developing a program to simulate images of the sky for a desired field size using tabulated values for star number densities by magnitude. Then utilizing the PSF data produced by the Dragonfly Telephoto Array in their PASP paper, convolving the PSF image with the produced simulated image to find the average brightness sampled throughout the sky. As our primary goal is to detect ultra-low surface brightness objects, we want to understand the scattering of starlight to a random point over very large angles as this will be the dominant source of systematic noise. Where the goal is to reach ~32 mag arcsec^{-2} and beyond of understanding.

- **(Group members responsible for above writing and development: Michael Smith and John Green)**

Hardware Communication Software

We are developing a client using python packages called Flask and PyIndi-Client that will be responsible for communicating instructions to hardware mounted to each telescope. The client will be installed on six Raspberry Pi 4s located on site in Chile, and each will be responsible for communicating with a focuser, filter wheel, dust cover, and camera. The client will receive a list of instructions from a scheduled observation in the form of http requests, and pass on the necessary instructions to each piece of hardware in the correct order to complete the observation. Once completed, the client will be able to automatically handle any requests to change the status or configuration of the mounted hardware and report back with an error or success message.

- **(Group members responsible for above writing and development: Stephen Berg and Jonathan Tekverk)**