10593 - The Dynamical Mass of the Bright Cepheid Polaris

Cycle: 14, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Nancy R. Evans (PI)	**Smithsonian Institution Astrophysical Observatory**	**nevans@cfa.harvard.edu**
Dr. Howard E. Bond (CoI)	Space Telescope Science Institute	bond@stsci.edu
Dr. Giuseppe Bono (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Roma	bono@mporzio.astro.it
Dr. Margarita Karovska (CoI)	Smithsonian Institution Astrophysical Observatory	mkarovska@cfa.harvard.edu
Dr. Edmund Nelan (CoI)	Space Telescope Science Institute	nelan@stsci.edu
Dr. Dimitar D. Sasselov (CoI)	Harvard University	sasselov@cfa.harvard.edu
Dr. Gail Schaefer (CoI)	Space Telescope Science Institute	gschaefer@stsci.edu

VISITS

Visit	*Targets*	*Configurations*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) POLARIS	ACS/HRC	1	20-Jun-2005 11:30:58.0	yes

1 Total Orbits Used

ABSTRACT

Cepheid variables are of central importance in Galactic and extragalactic astronomy. They are the primary standard candles for measuring extragalactic distances, and they provide critical tests of stellar-evolution theory. Surprisingly, however, there is not a single Cepheid with a purely dynamical measurement of its mass.

Polaris (alpha UMi) is the nearest and brightest of all Cepheids. It offers the unique opportunity to measure the dynamical mass of a Cepheid, because it is in a binary system for which a single-lined spectroscopic orbit is already available. We show that the binary should be easily resolved in the UV using ACS/HRC, thus providing the first direct detection of the companion. In the present proposal we request one HST orbit in order to make this detection and measure the separation. We show that this initial detection, combined with the HST/FGS parallax (see below), will provide a mass accurate to 0.9 Msun. Only HST's combination of high spatial resolution and UV sensitivity can achieve this result. We plan to continue the program in future cycles, leading to rapid refinement of the dynamical mass measurement of the Cepheid.

The parallax is a key ingredient in the mass determination. In an ongoing multi-year program (GO-9888, GO-10113), we are using the FGS to improve significantly upon the Hipparcos parallax of Polaris. The ACS imaging proposed here will thus provide extremely valuable astrophysical information from a very modest additional investment of observing time.

OBSERVING DESCRIPTION

The observations with ACS/HRC will consist of a series of 0.5-sec exposures in F220W, with dithering to improve the astrometric accuracy. The aim is to resolve the close companion of Polaris, and measure the separation and position angle. The target will be positioned in the HRC field of view so as to also show the wide companion, Polaris B, which will serve as a check on the position angle measurement.

Visit

Proposal 10593, Visit 01 Mon Jun 20 15:31:03 GMT 2005

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: SCHED 30%; BEFORE 01-SEP-2005:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-HRC-DITHER-LINE Purpose=DITHER Number Of Points=4 Point Spacing=1.9 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=5.8 Angle Between Sides= Center Pattern=true		(1-4)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	POLARIS Alt Name1: Alpha UMi	RA: 02 31 29.2000 (37.8716667d) Dec: +89 15 45.90 (89.26275d) Equinox: J2000 Plate Id: (?)	Proper Motion RA: 0.230315s/yr Proper Motion Dec: -0.01175"/yr Parallax: 0.00756" Epoch of Position: 1991.25	V=1.98+/-0.1	Coordinate Source: HIPPARCOS/TYCHO_CATALOGUE

Comments: Coordinates are from Hipparcos, but are adjusted so as to place the center of the field of view one-third of the way between Polaris A and Polaris B (which are separated by 18"). This will place both stars within the HRC field of view, as desired, with Polaris A about 6" from the center.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) POLARIS	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 1-4 (1)	0.1 Secs X 3 *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***

Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
2		(1) POLARIS	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 1-4 (1)	0.2 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
3		(1) POLARIS	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 1-4 (1)	0.3 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
4		(1) POLARIS	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 1-4 (1)	0.4 Secs X 2	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Proposal 10593 - Visit 01 - The Dynamical Mass of the Bright Cepheid Polaris

Orbit Structure