



10891 - The Dynamical Mass of the Bright Cepheid Polaris

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets</i>	<i>Configurations</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) POLARIS (2) POLARIS-B	ACS/HRC	1	12-Jun-2006 21:19:49.0	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, until now there was 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. In Cycle 14, we resolved the system in the UV using ACS/HRC, thus providing the first direct detection of the companion, as well as a first approximation to the dynamical mass. In the present proposal we request one HST orbit per year for the next 3 Cycles, in order to refine the visual orbit. Combined with the HST/FGS parallax (see below), this program will provide an accurate mass for the Cepheid (the error should be about 0.5 Msun by Cycle 17), and the only one based purely on dynamical information. Only HST's combination of high spatial resolution and UV sensitivity can achieve this result.

The parallax is a key ingredient in the mass determination. In an ongoing multi-year program (GO-9888, GO-10113, GO-10482), we are using the FGS to improve significantly upon the Hipparcos parallax of Polaris. The continued 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 0.3-sec exposures in F220W, with dithering to improve the astrometric accuracy. At each of 4 dither positions we will obtain 5x0.3 sec exposures, for a grand total of 20 frames. 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.

We will then move the telescope so as to place the companion Polaris B at the SAME set of 4 dither positions used for Polaris A. At each of the 4 positions we will take 4x20 sec, for a grand total of 16 frames. The purpose of these exposures is for Polaris B to provide a PSF of a single star at the same positions in the field of view used for the very close binary Polaris A, and exposed to the same count level as for Polaris A (since the flux ratio between B and A is 0.015).

Proposal 10891 - Visit 01 - The Dynamical Mass of the Bright Cepheid Polaris

Tue Jun 13 01:19:54 GMT 2006

Visit		Proposal 10891, Visit 01 Diagnostic Status: No Diagnostics Scientific Instruments: ACS/HRC Special Requirements: ORIENT 253.43965D TO 253.43965 D; BETWEEN 01-AUG-2006:00:00:00 AND 15-OCT-2006:00:00:00				
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), (2)	
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	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	Reference Frame: ICRS
<i>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.</i>						
(2)	POLARIS-B Alt Name1: ALPHA-UMI-B	RA: 02 30 16.6500 (37.5693750d) Dec: +89 15 34.30 (89.25953d) Equinox: J2000	Proper Motion RA: 0.230315s/yr Proper Motion Dec: -0.01175"/yr Parallax: 0.00756" Epoch of Position: 1991.25	V=8.5+/-0.2	Reference Frame: ICRS	
<i>Comments: These coordinates will place Polaris B at the same location in the FOV as Polaris A, as desired.</i>						

Proposal 10891 - Visit 01 - The Dynamical Mass of the Bright Cepheid Polaris

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
Exposures	1	(1) POLARIS	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 1-1 (1)	0.3 Secs X 5	
	<i>[==>(Pattern 1, Copy 1)]</i> <i>[==>(Pattern 1, Copy 2)]</i> <i>[==>(Pattern 1, Copy 3)]</i> <i>[==>(Pattern 1, Copy 4)]</i> <i>[==>(Pattern 1, Copy 5)]</i> <i>[==>(Pattern 2, Copy 1)]</i> <i>[==>(Pattern 2, Copy 2)]</i> <i>[==>(Pattern 2, Copy 3)]</i> <i>[==>(Pattern 2, Copy 4)]</i> <i>[==>(Pattern 2, Copy 5)]</i> <i>[==>(Pattern 3, Copy 1)]</i> <i>[==>(Pattern 3, Copy 2)]</i> <i>[==>(Pattern 3, Copy 3)]</i> <i>[==>(Pattern 3, Copy 4)]</i> <i>[==>(Pattern 3, Copy 5)]</i> <i>[==>(Pattern 4, Copy 1)]</i> <i>[==>(Pattern 4, Copy 2)]</i> <i>[==>(Pattern 4, Copy 3)]</i> <i>[==>(Pattern 4, Copy 4)]</i> <i>[==>(Pattern 4, Copy 5)]</i>	[1]							
	2	(2) POLARIS-B	ACS/HRC, ACCUM, HRC-FIX	F220W	CR-SPLIT=NO; GAIN=4		Pattern 2-2 (1)	20.0 Secs X 4	
	<i>[==>(Pattern 1, Copy 1)]</i> <i>[==>(Pattern 1, Copy 2)]</i> <i>[==>(Pattern 1, Copy 3)]</i> <i>[==>(Pattern 1, Copy 4)]</i> <i>[==>(Pattern 2, Copy 1)]</i> <i>[==>(Pattern 2, Copy 2)]</i> <i>[==>(Pattern 2, Copy 3)]</i> <i>[==>(Pattern 2, Copy 4)]</i> <i>[==>(Pattern 3, Copy 1)]</i> <i>[==>(Pattern 3, Copy 2)]</i> <i>[==>(Pattern 3, Copy 3)]</i> <i>[==>(Pattern 3, Copy 4)]</i> <i>[==>(Pattern 4, Copy 1)]</i> <i>[==>(Pattern 4, Copy 2)]</i> <i>[==>(Pattern 4, Copy 3)]</i> <i>[==>(Pattern 4, Copy 4)]</i>	[1]							

