



11293 - The Dynamical Mass of the Bright Cepheid Polaris

Cycle: 16, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) POLARIS (2) POLARIS-B	WFPC2	1	06-Jun-2007 23:11:48.0	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 WFPC2 imaging proposed here is a continuation of our program initiated with the ACS. These observations will provide extremely valuable astrophysical information from a very modest additional investment of observing time.

OBSERVING DESCRIPTION

The observations with WFPC2/PC1 will consist of a series of 0.8-sec exposures of Polaris A in the F218W filter, with dithering to improve the astrometric accuracy. We will use a 3-point dither pattern with half-pixel sampling. At the first 2 dither positions we will obtain 3x0.8 sec exposures and at the last dither position we will obtain 2x0.8 sec exposures for a grand total of 8 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 PC1 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 selected an ORIENT that would align the wide binary, Polaris A-B, to be parallel with the x-axis of the WFPC2/PC1 detector to minimize CTE effects.

We will then move the telescope so as to place the companion Polaris B at the SAME set of 3 dither positions used for Polaris A. At each of the 3 positions we will take 2x50 sec exposures, for a grand total of 6 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).

Visit	Proposal 11293, Visit 01, implementation										Thu Jun 07 03:11:54 GMT 2007
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: WFPC2										
	Special Requirements: ORIENT 274.0D TO 277.0 D; BEFORE 31-OCT-2007:00:00:00										
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	POLARIS	RA: 02 31 12.5880 (37.8024500d)		Proper Motion RA: 0.230315s/yr		V=1.98+/-0.1		Reference Frame: ICRS		
		Alt Name1: ALPHA-UMI	Dec: +89 15 45.00 (89.26250d)		Proper Motion Dec: -0.01175"/yr						
			Equinox: J2000		Parallax: 0.00756"						
	Epoch of Position: 1991.25										
	Comments: Coordinates are from Hipparcos, but are adjusted so as to place the center of the field of view half of the way between Polaris A and Polaris B (which are separated by 18"). This will place both stars within the PC field of view, as desired, with Polaris A about 9" from the center.										
	(2)	POLARIS-B	RA: 02 29 59.7558 (37.4989825d)		Proper Motion RA: 0.230315s/yr		V=8.5+/-0.2		Reference Frame: ICRS		
		Alt Name1: ALPHA-UMI-B	Dec: +89 15 33.42 (89.25928d)		Proper Motion Dec: -0.01175"/yr						
			Equinox: J2000		Parallax: 0.00756"						
	Epoch of Position: 1991.25										
	Comments: These coordinates will place Polaris B at the same location in the FOV as Polaris A, as desired.										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]		Orbit
	1		(1) POLARIS	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2,-10		0.8 Secs X 3		
									[==>(Copy 1)]		[1]
									[==>(Copy 2)]		
									[==>(Copy 3)]		
	2		(1) POLARIS	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2.501,-10.25		0.8 Secs X 3		
									[==>(Copy 1)]		[1]
									[==>(Copy 2)]		
									[==>(Copy 3)]		
	3		(1) POLARIS	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2.25,-10.501		0.8 Secs X 2		
									[==>(Copy 1)]		[1]
									[==>(Copy 2)]		
	4		(2) POLARIS-B	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2,-10		50.0 Secs X 2		
								[==>(Copy 1)]		[1]	
								[==>(Copy 2)]			
5		(2) POLARIS-B	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2.501,-10.25		50.0 Secs X 2			
								[==>(Copy 1)]		[1]	
								[==>(Copy 2)]			
6		(2) POLARIS-B	WFPC2, IMAGE, PC1	F218W	ATD-GAIN=15	POS TARG -2.25,-10.501		50.0 Secs X 2			
								[==>(Copy 1)]		[1]	
								[==>(Copy 2)]			

