

The Southern Hemisphere Asteroid Radar and Optical Program

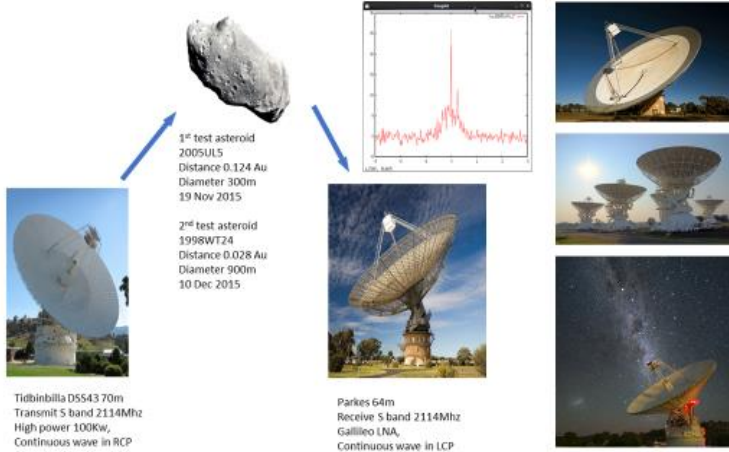
Ed Kruuzins^{1,2}, Lance A.M.Benner³, Russell Boyce¹, Melrose Brown¹, David Coward⁵, Guifre Molera Calves⁴, Sam Darwell¹, Philip G.Edwards², Jon D.Giorgini³, Shinji Horiuchi², Andrew Lambert¹, T.Joseph Lazio³, Ronglin R.Liou³, Shantanu P.Naidu³, Edwin Peters¹, Chris J.Phillips², Jamie Stevens²

¹ University of New South Wales, Canberra, Australia, ² Commonwealth Scientific Industrial Research Organisation, Sydney, Australia, ³ Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA, ⁴ University of Tasmania, Hobart, Tasmania, Australia, ⁵ University of Western Australia, Perth, Western Australia, Australia

Augmentation of Radar using Small Aperture Optical Telescopes

Near Earth Asteroid Detection using Bistatic Radar

- In 2015 the Southern Hemisphere Asteroid Radar Program (SHARP) began its first radar observations using available antenna time on the 70m and 34m antennas located at the Canberra Deep Space Communication Complex (CDSCC).
- Doppler compensated continuous wave signal transmitted at near Earth asteroid targets at either 2.114 GHz (14.2cm S band) or 7.15945 GHz (4.2cm X band).
- Reflected echoes were received at the 64m Parkes or 6x22m Australia Telescope Compact Array (ATCA) antennas at Narrabri Australia, depending upon schedule availability of these facilities.



- In 2022 we began a program of augmenting SHARP observations with rapidly acquirable sub-metre-class 0.3-0.5m optical apertures such as those managed by UNSW.
- Target set is exclusively Apollo/Aten class NEOs because of their Earth orbit crossing nature and classification as potentially hazardous asteroids (PHAs).
- UNSW manages two sub-metre class wide field optical telescopes (Falcon and Viper).
 - The USAFA-led Falcon Telescope Network includes a node in Canberra operated by UNSW Canberra
 - 0.5m f8.1 main telescope with a 4m focal length.
 - Astrotech AT106 0.1m f6.5 refractive viewfinder telescope with focal length 690mm.
 - The currently installed cameras on both telescopes are cooled, Atik 414ex (SONY ICX825 sensor with 1380x1040 6.46um square pixels)
 - The pixel field of view from the main telescope is 1.6 μ rad, and 6.5 μ rad in the viewfinder. Observations can be automatically or manually operated.



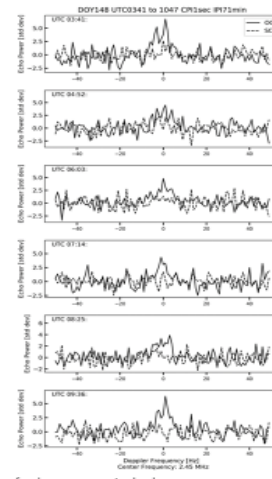
Next Steps for Southern Hemisphere Asteroid observations

- Leveraging the progress from the NEA campaign in the first half of 2022, we propose continuing with SHARP observations in the latter part of 2022 and early 2023 including:
 - Future NEA target planning for radar bistatic and small optical telescopes
 - Simulation of echo signals and interpretation vs NEO characteristics
 - Development of Stokes Vector Analysis with existing radar bistatic NEA data
 - Translation asteroid target interpretations to near Earth human made objects
- New NEA targets are proposed for the latter half of 2022 and early 2023 including further Apollo and Aten class asteroids:
 - 2005 LW3, 2015 RN35, 2014 HK129, 2010 XC15, 2011AG5 and 2005YY128.
 - CDSCC and ATCA antennas for bistatic radar
 - The Falcon 0.5m, Viper 0.4m, UWA Zadko 1.0m, Perth Observatory C-14 and NZ 0.35m small aperture optical telescopes are proposed to support SHARP observations.
 - UTAS array of radio telescopes at Katherine (NT) and Hobart (TAS), including three (12m, 26m and 30m) antennas, will also join the campaign.
- Build a wider Southern Hemisphere student research and supervisor/mentor group



2022 Observations

NEA	Class	Date (DOY)	Approx Diameter [m]	Range [LD]	SHARP Configuration	Abs Mag	Vis	Optical Scope
2001 CB21	Apollo	4Mar 2022 (063)	500-1200	12.8	CDSCC-34m Tx/ATCA Rx	18.5		Falcon 0.5m (Clouded)
2008 AG33	Apollo	27Apr 2022 (117)	300-800	8.4	CDSCC-70m Tx/ATCA Rx	19.4		Falcon 0.5m Perth C-14
2012 UX68	Apollo	15May 2022 (135)	30-120	2.5	CDSCC-70m Tx/ATCA Rx	24.2		Falcon 0.5m (Clouded) NZ 0.35m
1989 JA	Apollo	27-28 May 2022 (147-148)	1800	10.5	CDSCC-70m Tx/ATCA Rx	17.8		Falcon 0.5m incl. Spectroscopy
2022 LV	Apollo	25Jun 2022 (176)	20-40	2.0	CDSCC-70m Tx/ATCA Rx	25.3		Magnitude beyond limits



During January to July 2022, the southern hemisphere asteroid radar program (SHARP) observed five NEO's together with the family of sub-metre optical telescopes