# Deep Space Radar/Optical Detection of Near Earth Asteroids from the Southern Hemisphere.

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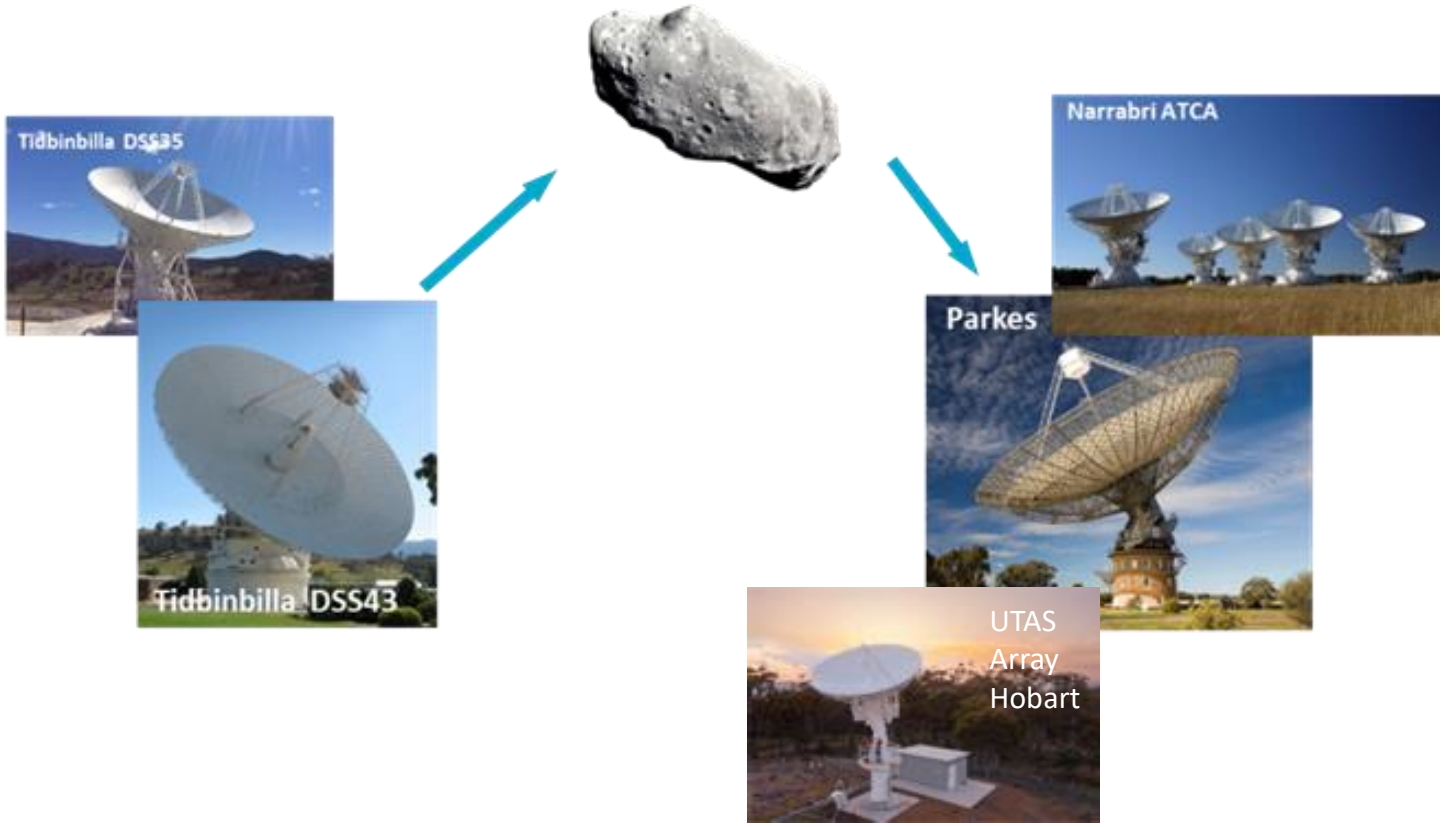
# NEO Detection from Southern Hemisphere from 2015
## using Scientific Bistatic Radar.

- In 2015 the Southern Hemisphere Asteroid Radar Program began its first scientific radar tests*.
- Doppler compensated CW transmission at 2.11 GHz (14.2cm S band) or 7.14 GHz (4.2cm X band).
- Transmit from 70m and 34m Tidbinbilla antennas.
- Reflected echoes successfully received at 64m Parkes
- Reflected echoes successfully received at 5x22m Australia Telescope Compact Array Narrabri Australia
- Joined by University of Tasmania 12m, 26m and 30m antennas April 2021.



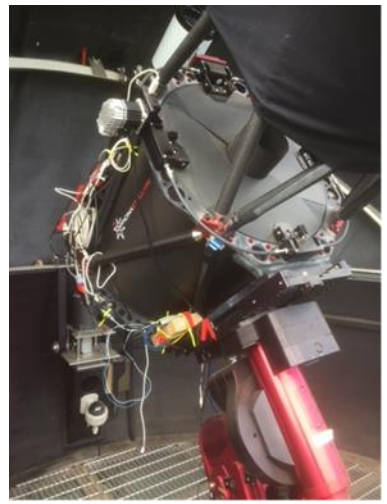

Antennas and telescopes in the Southern Hemisphere Asteroid Radar Program (SHARP).

*"First Detection of Two Near Earth Asteroids with a Southern Hemisphere Planetary Radar System" Benson.C, Reynolds.J, Stacy.N, Benner.L, Edwards.P, Baines.G, Boyce.R, Giorgini.J, Jao.J, Martinez.G, Slade.M, Teitlebaum.L, Anabtawi.A, Kahan.D, Oudrhiri.K, Phillips.C, Stevens.J, Kruzins.E, Lazio.J. Radio Science52 (11), 1344-1351 2017

# NEO Detection from Southern Hemisphere from 2022

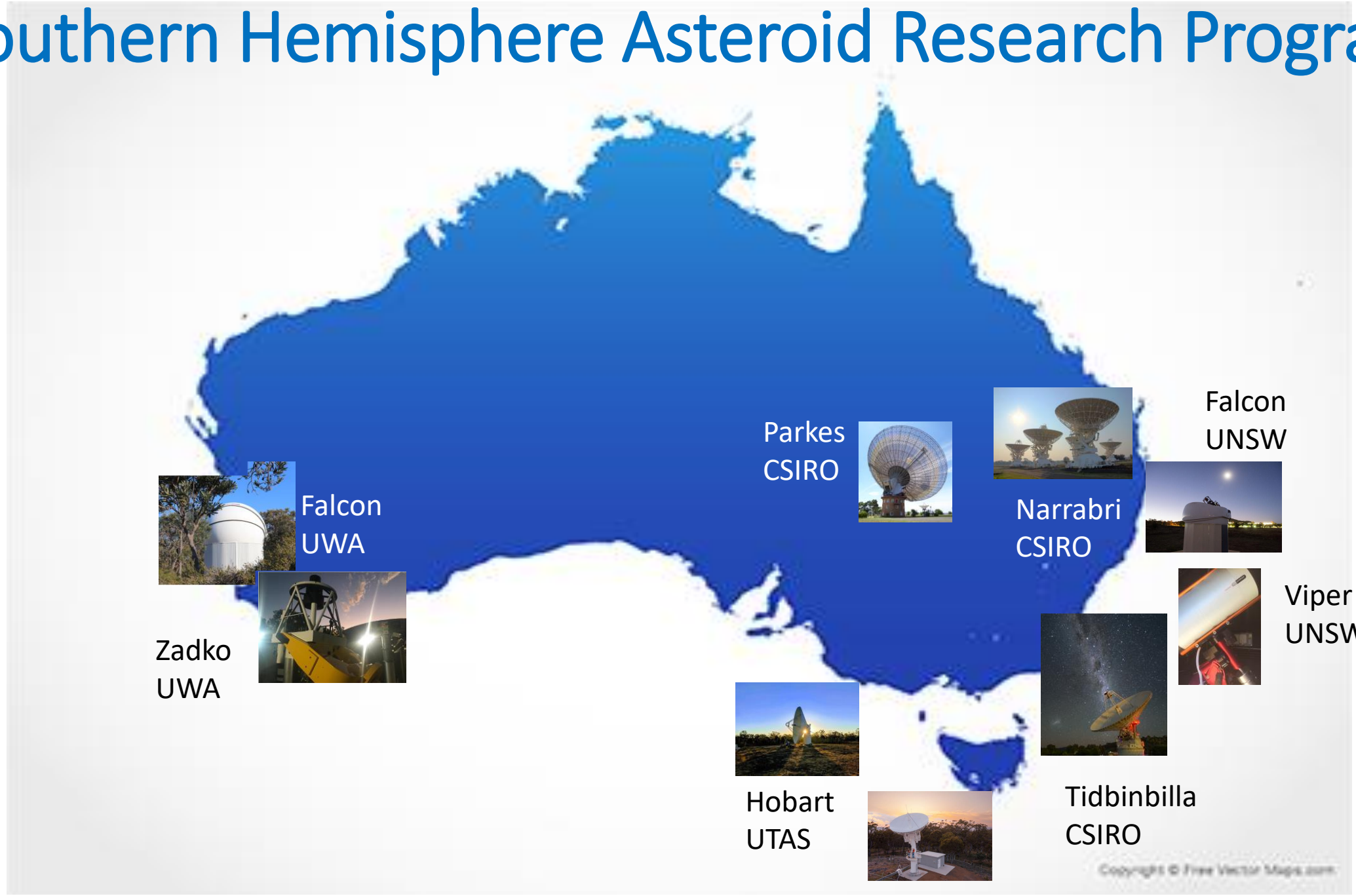
## Radar Augmentation using Small Optical Telescopes

- In 2022 a program of augmenting RADAR observations with sub-metre-class 0.3-0.5m optical apertures began*.
- Why - optical systems have a flexible search capacity, are rapidly tasked, cheap to operate, provide good astrometric and photometric results and are operationally adaptable with large radio frequency systems.
- Targets are exclusively Apollo/ATEN class NEOs because of their Earth orbit crossing nature and hazardous classification.
- Sub-metre class wide field optical telescopes in this group:
  - USAFA-led 0.5m f8.1 Falcon Telescope Network includes nodes in Canberra ACT and Gin Gin WA (operated by UNSW and UWA)
  - Viper 0.4m telescope (UNSW)
  - Zadko 1m and C14 telescopes (UWA)



*"Augmentation of a Southern Hemisphere Deep Space Bistatic Radar with Small Optical Systems to Detect Near Earth and other Space Objects. " Kruzins.E, etal. Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference Maui, HI; 2022, USA

# Southern Hemisphere Asteroid Research Program

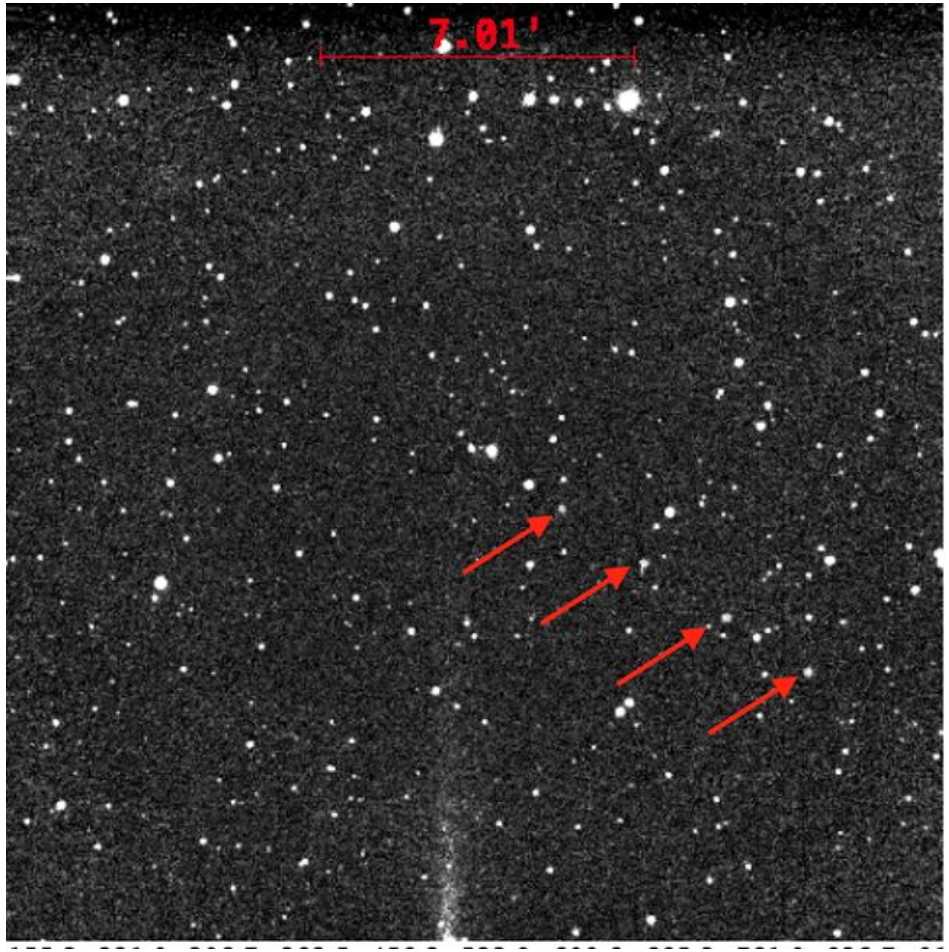


# Southern Hemisphere Asteroid Observations 2022-23

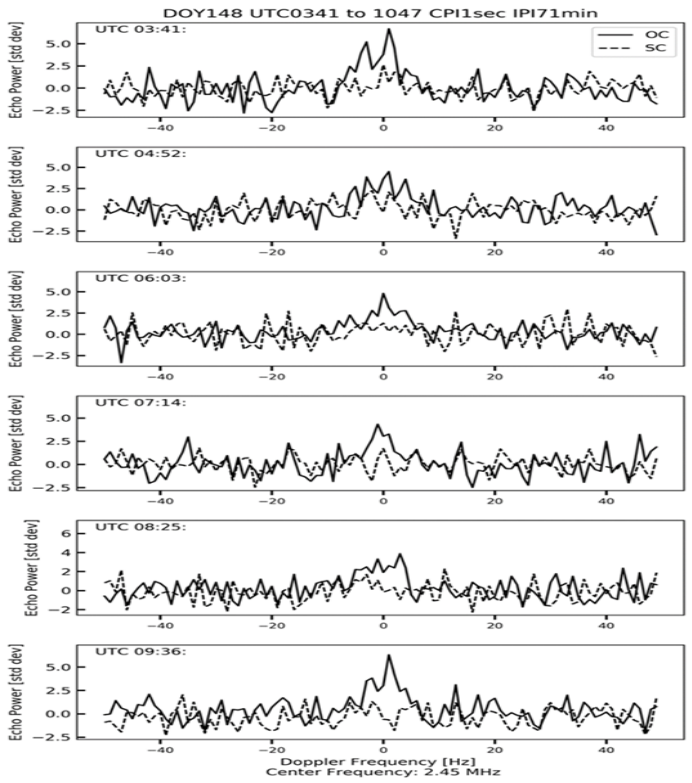
| Asteroid | Date | Approx. Diam Km | Range (AU) | Comments<br>PHA (Potentially Hazardous Asteroid) |
|---|---|---|---|---|
| 2005 LW3 | 2022 Nov 22-23 | 0.15 | 0.0110 | Observed in Radar and optical, PHA |
| 2015 RN35 | 2022 Dec 14-15 | 0.08 | 0.0053 | Observed in optical , PHA<br>Candidate for a space mission |
| 2014 HK129 | 2022 Dec 19-20 | 0.19 | 0.018 | Observed in Radar, PHA |
| 2010 XC15 | 2022 Dec 26-27 | 0.17 | 0.0073 | Observed in optical, PHA |
| 2011 AG5 | 2023 Feb 2-3 | 0.16 | 0.012 | Observed in Radar and optical, PHA<br>Candidate for a space mission |
| 2005 YY128 | 2023 Feb 15-16 | 0.95 | 0.031 | Observed in Radar and optical PHA |
| 2012 KY3 | 2023 Apr 13 | 0.66 | 0.033 | Observed in Radar and optical PHA |
| 2006 HV5 | 2023 Apr 27 -28 | 0.31 | 0.018 | Observed in Radar, PHA |
| 1994 XD | 2023 Jun 9-10 | 0.48 | 0.038 | Observed in Radar and optical, PHA |
| 2018 UY | 2023 Jul 11-12 | 0.24 | 0.020 | Observed in Radar and optical, PHA |
| 2020 UQ3 | 2023 Jul 15-16 | 0.06 | 0.019 | Observed in Radar, PHA |
| 2016 LY48 | 2023 Sep 17-18 | 0.18 | 0.0111 | Large pointing uncertainties? |

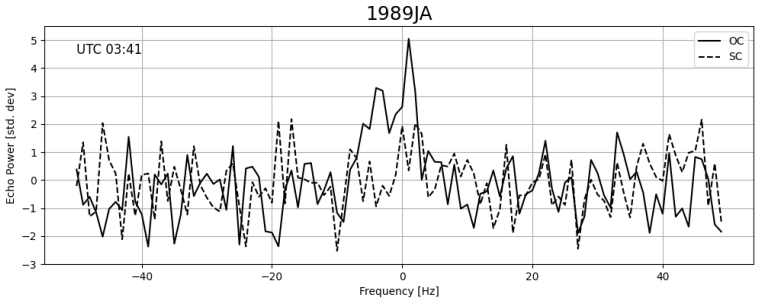
# 1989 JA 27-28 May 2022- NEO with a companion

Orbits Sun every 862 days, diameter of 1800m range 8 lunar distances (LD).

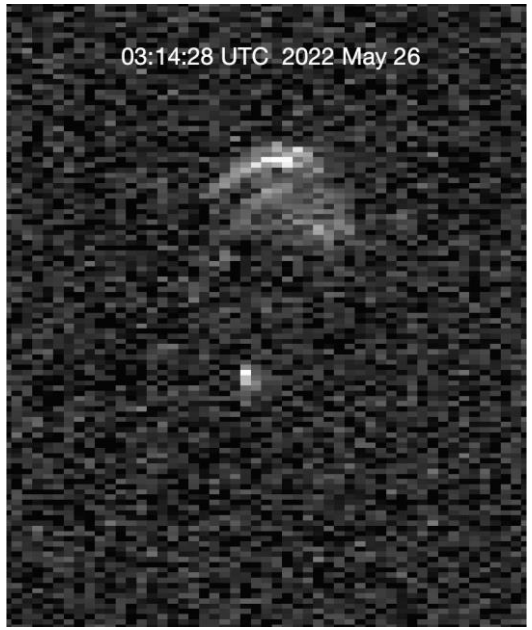



Courtesy of Gilmore, Kilmarten, Glassey 0.35m
F11 optical telescope NZ special observers



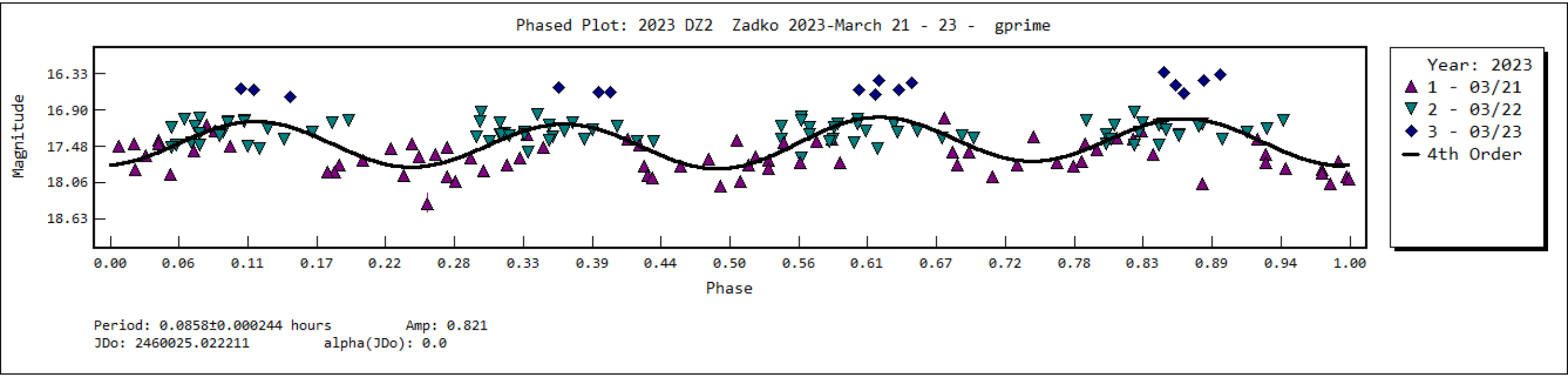



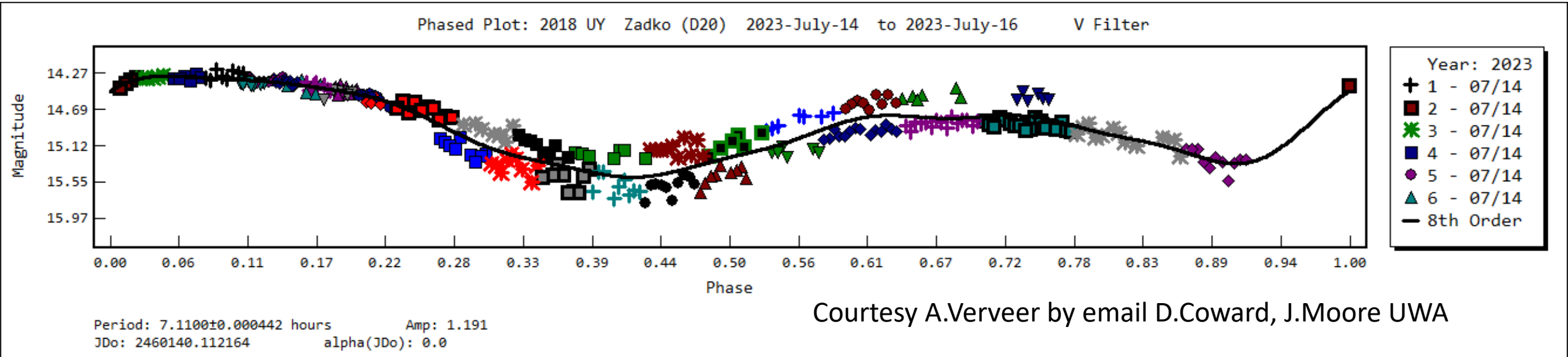

CDSCC/ATCA SHARP Radar spectra for 1989 JA
Courtesy S.Horiuchi & S.Darwell 2022.




Courtesy of GSSR
[Radar Observations of Near-Earth Asteroid 7335 1989 JA (nasa.gov)]

# 2023 DZ2 2123 Mar 2023 & 2018 UY 14-16 Jul 2023 – Improved light curves

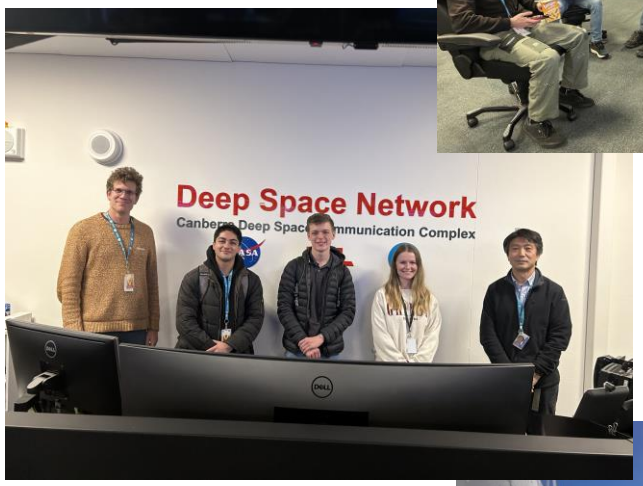



Courtesy A.Verveer by email D.Coward, J.Moore UWA

# Southern Hemisphere Asteroid Student Research Program

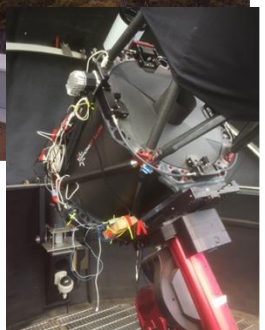
- The Southern Hemisphere Asteroid Research student program now includes graduate and post graduate students.
- Civilian and ADFA cadets/4th years
- Student research and supervisor/mentor group of Uni's, CSIRO, JPL
  - Future NEA target planning for radar bistatic and small optical telescopes
  - Assisting JPL/NASA databases
  - Simulation of echo signals and interpretation vs NEO characteristics
  - Development of Stokes Vector Analysis with existing radar bistatic NEA data


# Next steps for Southern Hemisphere Asteroid Research Program

- Leverage the progress from the NEO campaigns and continue with observations into 2024.
  - Plan new NEO targets for radar bistatic/small optical telescopes
  - Develop Stokes Vector Analysis further
  - Test new optical sensors including Event Based Sensors
  - Extend asteroid target interpretations to SDA.
  - Build STEM program

- Contribute to the International Asteroid Warning Network (IAWN)
  - Aid asteroid orbit determination and risk assessment
  - Contribute to global database on potentially hazardous asteroids and rapid response



See following ASRC paper by Dr Shinji Horiuchi