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Background Contamination of the Project Hephaistos Dyson Spheres Candidates

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ABSTRACT

Project Hephaistos recently identified seven M-dwarfs as possible Dyson Spheres (DS) candidates. We have cross-matched three of these candidates (A, B & G) with radio sources detected in various all-sky surveys. The radio sources are offset from the Gaia stellar positions by ~ 4.9, ~ 0.4 and ~ 5.0 arcseconds for candidates A, B, and G respectively. We propose that DOGs (Dust obscured galaxies) lying close to the line-of-sight of these M-dwarf stars significantly contribute to the measured WISE mid-IR flux densities in the WISE W3 and W4 wavebands. These three stars have therefore been misidentified as DS candidates. We also note that with an areal sky density of 9×10^{-6} per square arcsecond, Hot DOGs can probably account for the contamination of all 7 DS candidates drawn from an original sample of 5 million stars.

Keywords: extraterrestrial intelligence — radio continuum: stars

1. INTRODUCTION

Project Hephaistos (Suazo et al. 2024) recently proposed seven Dyson Sphere (DS) candidates by identifying sources with an IR excess from a sample of 5 million stars detected by Gaia, 2MASS, and WISE. The DS candidates are all M-type dwarfs, and natural explanations such as warm debris disks are ruled out as potential contaminating sources. To understand more about other potential sources of contamination in these systems, we compared the position of these stars with the publicly available data from various all-sky radio surveys.

2. SEARCH FOR RADIO SOURCE COUNTERPARTS

We cross-matched the seven candidates with the Very Large Array Sky Survey (VLASS, Gordon et al. (2021)), Rapid ASKAP Continuum Survey (RACS, Hale et al. (2021)), the FIRST survey (Helfand et al. 2015), the NRAO VLA Sky Survey (NVSS, Condon et al. (1998)), and the TIFR GMRT Sky Survey (TGSS, Intema et al. (2017)). We searched for radio sources within a radius of 10 arcseconds of the Gaia positions. We found radio sources associated with candidates A, B, and G with offsets of ~ 4.9, ~ 0.4 and ~ 5.0 arcseconds respectively. Candidate G is detected in multiple radio surveys. Table 1 summarises our findings.

3. DISCUSSION

Candidates A and G are associated with radio sources offset approximately ~ 5 arcseconds from their respective Gaia stellar positions. We suggest that these radio sources are most likely to be DOGs (dust-obscured galaxies) that contaminate the IR (WISE) Spectral-Energy Distributions (SEDs) of the two DS candidates. The offsets for candidate B are smaller, approximately ~ 0.35 arcsecond. Since M-dwarfs very rarely present persistent radio emission ($\leq 0.5\%$ of the sample observed by Callingham et al. (2021)), we suspect that this radio source is also associated with a background DOG lying very close to the line-of-sight. We note that the radio source associated with G has a steep spectral index with a best fit of $\alpha = -0.52 \pm 0.02$ - this value is typical of synchrotron emission from a radio-loud AGN with extended jets.

GAIA Candidate	Survey	ID	RA(J2000) (hms)	DEC(J2000) (°′″)	Total offset (arcsec)	RA offset (arcsec)	DEC offset (arcsec)	Flux density (mJy)	Frequency (MHz)
A	RACS-DR1	J124512.7-265206	12 45 12.783	-26 52 06.204	4.880	-2.215	-4.348	1.75	887.5
B	RACS-DR1	J035603.8-403148	03 56 03.831	-40 31 48.187	0.388	0.350	-0.167	2.90	887.5
G	VLASS	J233532.86-000424.9	23 35 32.865	-00 04 24.945	5.686	5.638	-0.737	25.45	3000
G	FIRST	J233532.8-000425	23 35 32.864	-00 04 25.300	5.728	5.623	-1.092	33.59	1400
G	NVSS	J233532-000425	23 35 32.780	-00 04 25.000	4.434	4.363	-0.792	33.90	1400
G	RACS-DR1	J233532.8-000425	23 35 32.849	-00 04 25.244	5.500	5.398	-1.036	46.39	887.5
G	TGSS	J233532.8-000426	23 35 32.849	-00 04 26.256	5.499	5.398	-1.048	113.20	150

Table 1. The radio source positions, offsets and flux densities associated with DS candidates A, B and G.

One specific class of background AGN that can explain the observations are Hot DOGs (hot dust-obscured galaxies) Assef et al. (2015). Hot DOGs have dust temperatures ≥ 60 K and are detected as WISE W1 and W2 dropouts - they are well detected at longer wavelengths in W3 and W4 (Tsai et al. 2015). With a resolution of 6-12 arcseconds across the W1-W4 bands, the radio counterparts of A, B, and G all fall within the primary response of WISE.

Hot DOGs also have a surface density of approximately 1 per 31 square degrees (Assef et al. 2015), which translates to about 9×10^{-6} per square arcsecond. This density is therefore sufficient to explain the levels of contamination observed in large-scale surveys like the one conducted for Project Hephaistos, which analysed approximately 5 million stars. We propose that all seven DS candidates reported by Suazo et al. (2024) have very likely been misidentified, with their SEDs being significantly contaminated by background Hot DOGs in the WISE W3 and W4 bands. In this scenario, the other 4 DS candidates (C, D, E, and F) are presumably radio quiet systems. Deeper, and higher-resolution radio observations of the 7 candidates are warranted.

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