The Magnificent Seven see (infra)red

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Motivation:

Accretion from supernova fallback disks has been suggested as a possibility to explain the persistent emission of Magnetars. According to this theory (e.g., Alpar 2001) the X-ray thermal isolated neutron stars (aka the Magnificent Seven) might have been born with such disks as well. Their disks would have been, however, less massive than the suggested disks around magnetars. Depending on the environment conditions, such disks could have survived until today. Since the Magnificent Seven are much closer than the Magnetars, they can be easier probed for potential faint disk emission. We search for the disks around the Magnificent Seven using Infrared and submm observations.

Spitzer Space Telescope

astrometric accuracy: 0.3"
(checked with 2MASS source positions)

Instrument:
Infrared Array Camera
(IRAC, Fazio et al. 2004)

Band	Band	FWHM of PSF
IRAC1	3.6 μm	1.66"
IRAC2	4.5 μm	1.72"

Herschel Space Telescope

absolute pointing error: 1.1" - 2.4"

Instrument:
Photodetector Array Camera and Spectrometer (PACS, Poglitsch et al. 2010)

Band	Bandwidth	Beam size (FWHM)
Blue	60-85 μm	5.5" x 5.8"
Red	130-210 μm	10.5" x 12.0"

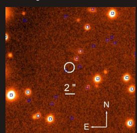
RX J0720.4-3125

- shows long-term changes in its X-ray spectrum (e.g., Hohle et al. 2012), impact by an asteroid could be one explanation (van Kerkwijk et al. 2007)
If so, a debris disk could be the asteroid reservoir.

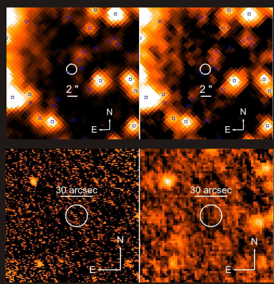
INS positional uncertainty ~80 mas at the time of the Spitzer observation
Herschel pointing accuracy ~1.1"

not detected with *Spitzer*

not detected with *Herschel*



VLT ISAAC *H (1.6μm)*, blue points indicate VLT FORS *B* sources. (Posselt et al. 2009, Motch et al. 2003)



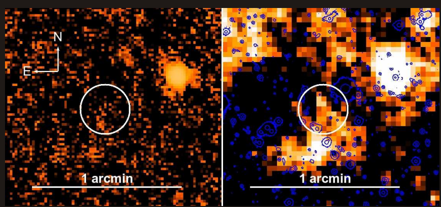
(radius = 10")

Blue <5.2 mJy   Red <9.4 mJy

RX J0806.4-4123

INS positional uncertainty 1,4" (including proper motion upper limit)
Herschel pointing accuracy ~1.1"

potential detection



(radius = 10", blue contours: VLT ISAAC *H*-band)

5σ Blue <4.9 mJy

F(Red)=10±5 (5σ) mJy
(5" aperture, 10 different apertures for background)

RX J2143.0+0654

potential detection

INS positional uncertainty 3,4" (including proper motion upper limit)
Herschel pointing accuracy ~1.1"

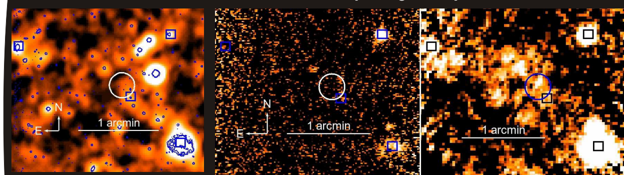


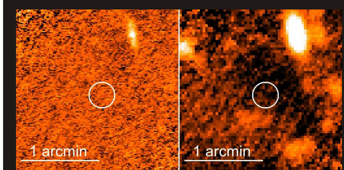
image: WISE 3.4 μm
blue contours: VLT ISAAC *H*-band

(radius = 10")

Peak position of red emission 3.4" North of optical INS position (Schwope et al. 2009)
no known counterpart at any other wavelength (X-ray,optical, NIR, IR) at this position
5σBlue<=5.0 mJy
F(Red)=7.8±4.8(5σ) mJy
(unreliable because of source blend)

RX J0420.0-5022

INS positional uncertainty better than 1"
Herschel pointing accuracy ~1.1"



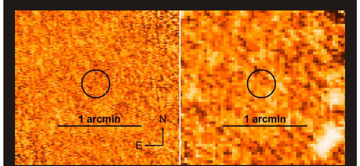
(radius = 10")

➜ not detected with *Herschel*

5σ Blue <4.5 mJy   5σ Red <7.0 mJy

RX J1308.6+2127

INS positional uncertainty better than 1"
Herschel pointing accuracy ~1.1"



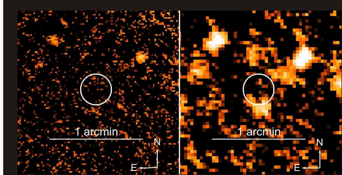
(radius = 10")

➜ not detected with *Herschel*

5σ Blue <1.7 mJy   5σ Red <5.2 mJy

RX J1605.3+3249

INS positional uncertainty better than 1"
Herschel pointing accuracy ~1.1"



(radius = 10")

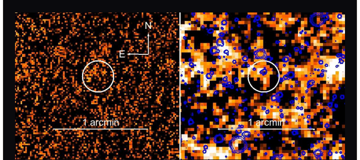
Potential red source at 5.4" North of INS position cannot be the INS.

➜ not detected with *Herschel*

5σ Blue <6.1 mJy   5σ Red <12.2 mJy

RX J1856.5-3754

INS positional accuracy better than 0.1", *Herschel* pointing accuracy only ~2.4" for this particular observation, could not be improved due to ambiguities in cross-matches to NIR sources



(radius = 10", blue contours: VLT ISAAC *H*-band)

5σ Blue <7.7 mJy

Red: there is a blend of sources in the North-East
Though there is emission (3σ) at the INS position, an INS counterpart is questionable.
Therefore: 5σ Red <7.8 mJy

Conclusions:

Five of the Magnificent Seven are undetected at 70 μm and 130 μm with *Herschel* flux limits ~5 mJy.
RX J0720.4-3125 is also undetected at the smaller *Spitzer* wavelengths 3.6 μm and 4.5 μm with flux limits < 5 μJy.

Close to the INS positions in the fields of RX J0806.4-4123 and RX J2143.0+0654 emission has been found in the 130 μm band.
Due to the large beam size in this *Herschel* band, follow-up observations, e.g., using millimeter interferometry, are required to confirm an association of the emissions to the INSs.

References:

Alpar 2001 (ApJ 554, 1245), Fazio et al. 2004 (ApJS 154, 10), Hohle et al. 2012 (MNRAS 423, 1194), Motch et al. 2003 (A&A 408, 323), Poglitsch et al. 2010 (A&A 518, 2), Posselt et al. 2009 (A&A 496, 533), Schwope et al. 2009 (A&A 499,267), van Kerkwijk et al. 2007 (ApJ 659, 149)

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