A&A 549, A23 (2013)
DOI: 10.1051/0004-6361/201220275

Astronomy
&
Astrophysics

Observations of the magnetars 4U 0142+61 and 1E 2259+586 with the MAGIC telescopes[⋆]

(Research Note)

J. Aleksić[1], L. A. Antonelli[2], P. Antoranz[3], M. Asensio[4], U. Barres de Almeida[5], J. A. Barrio[4], J. Becerra González[6,28], W. Bednarek[7], K. Berger[6,8], E. Bernardini[9], A. Biland[10], O. Blanch[1], R. K. Bock[5], A. Boller[10], G. Bonnoli[2], D. Borla Tridon[5], T. Bretz[11,29], E. Carmona[12], A. Carosi[2], P. Colin[5], E. Colombo[6], J. L. Contreras[4], J. Cortina[1], L. Cossio[13], S. Covino[2], P. Da Vela[3], F. Dazzi[13,30], A. De Angelis[13], G. De Caneva[9], E. De Cea del Pozo[14], B. De Lotto[13], C. Delgado Mendez[12], A. Diago Ortega[6,8], M. Doert[15], D. Dominis Prester[16], D. Dorner[10], M. Doro[17], D. Eisenacher[11], D. Elsaesser[11], D. Ferenc[16], M. V. Fonseca[4], L. Font[17], C. Fruck[5], R. J. García López[6,8], M. Garczarczyk[6], D. Garrido Terrats[17], M. Gaug[17], G. Giavitto[1], N. Godinović[16], A. González Muñoz[1], S. R. Gozzini[9], A. Hadamek[15], D. Hadasch[14,⋆⋆], D. Häfner[5], A. Herrero[6,8], J. Hose[5], D. Hrupec[16], B. Huber[10], F. Jankowski[9], T. Jogler[5,31], V. Kadenius[18], S. Klepser[1,32], M. L. Knoetig[5], T. Krähenbühl[10], J. Krause[5], J. Kushida[19], A. La Barbera[2], D. Lelas[16], E. Leonardo[3], N. Lewandowska[11], E. Lindfors[18], S. Lombardi[2], M. López[4], R. López-Coto[1], A. López-Oramas[1], E. Lorenz[5,10], M. Makariev[20], G. Maneva[20], N. Mankuzhiyil[13], K. Mannheim[11], L. Maraschi[2], B. Marcote[21], M. Mariotti[22], M. Martínez[1], D. Mazin[1,5], M. Meucci[3], J. M. Miranda[3], R. Mirzoyan[5], J. Moldón[21], A. Moralejo[1], P. Munar-Adrover[21], A. Niedzwiecki[7], D. Nieto[4], K. Nilsson[18,33], N. Nowak[5], R. Orito[19], S. Paiano[22], M. Palatiello[13], D. Paneque[5], R. Paoletti[3], J. M. Paredes[21], S. Partini[3], M. Persic[13,23], M. Pilia[24], J. Pochon[6], F. Prada[25], P. G. Prada Moroni[26], E. Prandini[22], I. Puljak[16], I. Reichardt[1], R. Reinthal[18], W. Rhode[15], M. Ribó[21], J. Rico[27,1], S. Rügamer[11], A. Saggion[22], K. Saito[19], T. Y. Saito[5], M. Salvati[2], K. Satalecka[4], V. Scalzotto[22], V. Scapin[4], C. Schultz[22], T. Schweizer[5], S. N. Shore[26], A. Sillanpää[18], J. Sitarek[1], I. Snidaric[16], D. Sobczynska[7], F. Spanier[11], S. Spiro[2], V. Stamatescu[1], A. Stamerra[3], B. Steinke[5], J. Storz[11], S. Sun[5], T. Surić[16], L. Takalo[18], H. Takami[19], F. Tavecchio[2], P. Temnikov[20], T. Terzić[16], D. Tescaro[6], M. Teshima[5], O. Tibolla[11], D. F. Torres[27,14], T. Toyama[5], A. Treves[24], M. Uellenbeck[15], P. Vogler[10], R. M. Wagner[5], Q. Weitzel[10], V. Zabalza[21], F. Zandanel[25], R. Zanin[21], N. Rea[14], and M. Backes[15]

(Affiliations can be found after the references)

Received 22 August 2012 / Accepted 25 October 2012

ABSTRACT

Context. Magnetars are an extreme, highly magnetized class of isolated neutron stars whose large X-ray luminosity is believed to be driven by their high magnetic field.

Aims. We study for the first time the possible very high energy γ-ray emission above 100 GeV from magnetars, observing the sources 4U 0142+61 and 1E 2259+586.

Methods. We observed the two sources with atmospheric Cherenkov telescopes in the very high energy range ($E > 100$ GeV). 4U 0142+61 was observed with the MAGIC I telescope in 2008 for about 25 h and 1E 2259+586 was observed with the MAGIC stereoscopic system in 2010 for about 14 h. The data were analyzed with the standard MAGIC analysis software.

Results. Neither magnetar was detected. Upper limits to the differential and integral flux above 200 GeV were computed using the Rolke algorithm. We obtain integral upper limits to the flux of 1.52×10^{-12} cm^{-2} s^{-1} and 2.7×10^{-12} cm^{-2} s^{-1} with a confidence level of 95% for 4U 0142+61 and 1E 2259+586, respectively. The resulting differential upper limits are presented together with X-ray data and upper limits in the GeV energy range.

Key words. stars: magnetars – stars: individual: 4U 0142+61 – stars: individual: 1E 2259+586 – radiation mechanisms: non-thermal – gamma rays: stars

1. Introduction

Magnetars are a peculiar class of neutron stars. Most of the about 20 known magnetars are characterized by strong dipolar magnetic fields ($\sim 10^{14}$–10^{15} Gauss) that are $\sim$10–1000 times higher than the average value in radio pulsars, near or even above the quantum electrodynamic field strength, $B_{\rm QED} = m_{\rm e}^2 c^3/e\hbar \sim 4.4 \times 10^{13}$ G (Harding & Lai 2006), although with two exceptions (Rea et al. 2010, 2012). They have bright X-ray luminosities ($L_{\rm x} \sim 10^{32}$–10^{36} erg s^{-1}) from 0.1–300 keV, longer rotation periods than most ordinary radio pulsars ($\sim$2–12 s), and very high period derivatives ($\sim 10^{-13}$–10^{-11} s s^{-1}). For more details

---

[⋆] FITS files are only available at the CDS via anonymous ftp to `cdsarc.u-strasbg.fr` (`130.79.128.5`) or via `http://cdsarc.u-strasbg.fr/viz-bin/qcat?J/A+A/549/A23`

[⋆⋆] Corresponding author: D. Hadasch, `hadasch@ieec.uab.es` see recent reviews on magnetars by Mereghetti (2008) and Rea & Esposito (2011).

The most successful model for explaining the X-ray emission from these objects invokes the decay and instability of their magnetic fields (Duncan & Thompson 1992; Thompson & Duncan 1993, 1995). The dichotomy between magnetars and ordinary pulsars may indicate different progenitors (Thompson & Duncan 1996). This scenario for birthing a magnetar postulates a very rapidly spinning proto-neutron star at birth, which would then have a high rotational energy. This excessive energy was searched in the supernova remnants (SNRs) surrounding magnetars. However, those SNRs show no excess in X-rays relative to those around normal pulsars (Vink & Kuiper 2006).

With this paper we aimed at testing whether the additional energy at birth could have gone in TeV emission.

To date, no magnetar has been detected at energies above 1 MeV. Although recently, the H.E.S.S. collaboration presented their discovery of extended TeV γ-ray emission toward the magnetar SGR 1806-20[1], it is doubtful that the emission is driven by the magnetar itself (Rowell et al. 2011). The *Fermi*-LAT Collaboration presented upper limits for 13 magnetars after 17 months of sky survey observations between 0.1 and 100 GeV (Abdo et al. 2010). Şaşmaz Muş & Göğüş (2010) studied specially the *Fermi* data of 4U 0142+61. Neither steady nor pulsed emission was found. In this work we present a search for the emission at very high energies (VHE; 200 GeV–50 TeV) from the two magnetars 4U 0142+61 and 1E 2259+586 with the MAGIC telescopes. These sources have been also observed by the VERITAS Collaboration and corresponding upper limits above an energy of 400 GeV have been presented in Guenette et al. (2009). The present MAGIC observations of these two magnetars extend the spectrum to lower energies, 200 GeV.

2. The observed magnetars

The source 4U 0142+61 is located at α_{2000}, δ_{2000} = $01^{\rm h}46^{\rm m}22\overset{\rm s}{.}407$, $+61°45'03\overset{''}{.}19$ at a distance of ~3.6 kpc. With an X-ray luminosity of $L_{\rm X} \sim 1 \times 10^{35}$ erg s^{-1} it is one of the most X-ray luminous magnetars known (McGill Pulsar Group 2012). This makes it a good target to search for persistent VHE emission. Long term spin period variations ($P \sim 8.7$ s) were discovered during observations with EXOSAT (Israel et al. 1994), leading to the measurement of the period derivative $\dot{P} \sim 2 \times 10^{-12}$ s s^{-1}, and consequently of the very strong magnetic field $B \sim 1.3 \times 10^{14}$ G (McGill Pulsar Group 2012). The bright 1–10 keV emission coming from 4U 0142+61 has been observed by many X-ray satellites (White et al. 1987; Israel et al. 1999; Patel et al. 2003; Rea et al. 2007a,b) revealing an X-ray spectrum typical of an Anomalous X-ray Pulsar (AXP), best described by an absorbed blackbody plus a power law ($N_{\rm H} \sim 10^{22}$ cm^{-2}, $kT \sim 0.4$ keV and $\Gamma \sim 3.62$). A very strong hard X-ray emission has been reported by INTEGRAL up to 250 keV, with a spectrum well modeled with a steep power-law with a photon index of ~1 (Kuiper et al. 2006). At the time of data taking with the MAGIC telescope, there were only COMPTEL upper limits in the MeV range suggesting a spectral break in the hard X-ray emission of this object. The upper limits, however, do not put strong constraints on the HE or VHE gamma-ray emission of the object, especially given the high systematic uncertainty of the background subtraction in the data COMPTEL analysis (Schönfelder 2004). Recently, the upper limits derived by the *Fermi*-LAT Collaboration (Abdo et al. 2010) and by Şaşmaz Muş & Göğüş (2010) point to a cutoff in the MeV band.

The AXP 1E 2259+586 is located at $\alpha_{2000}, \delta_{2000}$ = $23^{\rm h}01^{\rm m}08\overset{\rm s}{.}296$, $+58°52'44\overset{''}{.}45$ embedded in the SNR CTB109. The source has a magnetic field of $B \sim 0.59 \times 10^{14}$ G and a distance of ~4 kpc, making it a good candidate for MAGIC observations (McGill Pulsar Group 2012). *RXTE* measured the period ($P \sim 7$ s) and the period derivative ($\dot{P} \sim 0.5 \times 10^{-12}$ s s^{-1}) (Gavriil & Kaspi 2002). The X-ray spectrum is variable depending on the source emission state (Kaspi et al. 2003; Woods et al. 2004). After undergoing an outburst in 2002, the source returned into its possible quiescence state and the corresponding spectrum is best fitted by a blackbody plus a power law ($N_{\rm H} \sim 10^{22}$ cm^{-2}, $kT \sim 0.4$ keV and $\Gamma \sim 3.75$) (Zhu et al. 2008).

3. The MAGIC telescopes, analysis, and data

The MAGIC Collaboration operates two 17 m diameter imaging atmospheric Cherenkov telescopes on the Canary Island of La Palma. The data sets presented here were taken in 2008, i.e. before the second MAGIC telescope was operational (mono data), and in 2010 when both telescopes were already taking stereoscopic data. Details about the performance of MAGIC in mono and stereo mode can be found in Albert et al. (2008) and Aleksić et al. (2012). All data presented in this work were taken in the so-called wobble mode and were analyzed using the MARS analysis framework (Moralejo et al. 2009; Aleksić et al. 2012). The analyses presented here have an analysis threshold of 200 GeV. The upper limits were calculated using the Rolke algorithm (Rolke et al. 2005) with a confidence level (C.L.) of 95% assuming a Gaussian background and 30% of systematic uncertainty in the flux level. Since 1E 2259+586 is embedded in a SNR and may contain more than one emission region (see below) relevant parameters for the observations are the MAGIC field of view of 3.5° and the angular resolution of ~0.07° above 300 GeV (Aleksić et al. 2012).

4U 0142+61 was observed for 25.41 h. After quality cuts 16.58 h of effective observation time remain. These mono data were taken between August and December 2008 covering a zenith angle range between 33° and 40.6°.

Data for 1E 2259+586 were taken in stereo mode wobbling around the sky position 0.12° away from the magnetar to have the shell of the SNR and the magnetar in the same field of view. Given the angular resolution of the MAGIC telescopes, these two possible TeV sources would be spatially separable with MAGIC. The region was observed between August and November 2010 for 14.33 h within a zenith angle range of 29°–43°. After quality cuts this amounted to 8.22 h of effective observation time.

4. Results

Neither source was detected by MAGIC. We computed the integral flux upper limits above 200 GeV with 95% C.L. assuming a differential energy spectral shape of a power law with an index of 2.6, similar to that of the Crab Nebula spectrum. The results are given in Table 1. A 25% change in the photon index yields a variation of about 7%. In Fig. 1 we show the corresponding test statistic (TS)[2] map for 1E 2259+586. No excess was found

---

[1] Originally, magnetars were divided into two categories: soft gamma repeaters (SGRs) and anomalous X-ray pulsars (AXPs; Woods & Thompson 2006).

[2] Our test statistic is (Li & Ma 1983, Eq. (17)), applied on a smoothed and modeled background estimation. Its null hypothesis distribution mostly resembles a Gaussian function, but in general can have a somewhat different shape or width.

Table 1. Magnetar parameters taken from McGill Pulsar Group (2012), along with the MAGIC results presented here.

Source	Distance [kpc]	$B_{\rm surf}$ [10^{14} G]	$L_{\rm X}$ [10^{35} erg s^{-1}]	log ($L_{\rm rot}$) [erg s^{-1}]	Eff. obs. time [h]	Significance σ	Upper limit (95% C.L., $E > 200$ GeV) [cm^{-2} s^{-1}]
4U 0142+61	3.6 ± 0.4	1.3	1.1	32.10	16.58	−2.1	1.52×10^{-12} (0.70% C.U.)
1E 2259+586	4.0 ± 0.8	0.59	0.34	31.70	8.22	−0.5	2.70×10^{-12} (1.24% C.U.)

Notes. Crab Units (C.U.) are defined as a fraction of the Crab Nebula flux as measured by MAGIC (Aleksić et al. 2012).

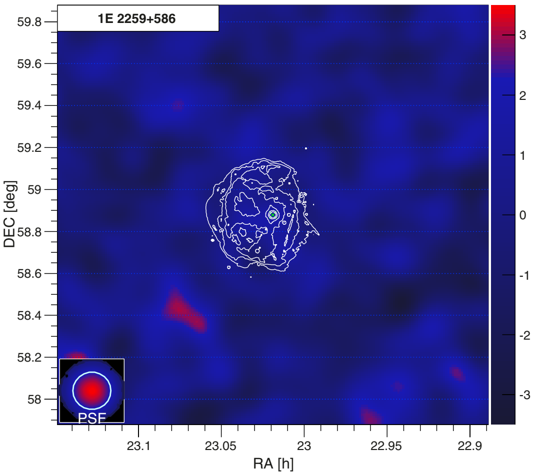

Fig. 1. TS map of 1E 2259+586. The green cross represents the magnetar position. The white contours show the X-ray emission of the surrounding SNR CTB 109 detected with the *XMM-Newton* satellite. The color scale represents the TS value.

at either the magnetar position nor at any location within the surrounding SNR. The TS map for 4U 0142+61 is not shown here, but shows the same flat behaviour. The upper limit for the extended SNR will be discussed elsewhere. The white contours represent the X-ray emission of the surrounding SNR detected with the *XMM-Newton* satellite (0.1–15 keV). We also searched for pulsations for both magnetars. For the pulsed analysis of 1E 2259+586 we used a timing solution valid at the epoch of the MAGIC observations, as derived by Içdem et al. (2012). We did not detect any significant pulsation at VHE energies. In the case of 4U 0142+61, we searched for pulsation using the ephemeris of Şaşmaz Muş & Göğüş (2010). We did not find any pulsation at VHE energies for this source either.

Since neither source experienced an outburst in X-rays during our observing intervals, we can compare our upper limits with data taken with different instruments during different quiescent epochs. In Figs. 2a,b we present the 0.1 keV–3 TeV multi-band spectral energy distribution (SED) of 4U 0142+61 (1E 2259+586), respectively. For both sources the corresponding differential and integral upper limits derived in this work are shown (red lines in Fig. 2). In the case of 4U 0142+61, the 0.1–200 keV data are from *XMM-Newton*-PN and INTEGRAL-ISGRI (Rea et al. 2007a; den Hartog et al. 2008; Gonzalez et al. 2010) plotted together with the 2σ COMPTEL upper limits (den Hartog et al. 2006; Kuiper et al. 2006). For 1E 2259+586 we show data points from *XMM-Newton*-PN (Woods et al. 2004) together with COMPTEL upper limits (Kuiper et al. 2006). The upper limits provided by the *Fermi*-LAT Collaboration were calculated for three different energy ranges (Abdo et al. 2010). For the overall energy bin from 0.1–10 GeV a photon index of 2.5 was assumed. A cutoff is mimicked by splitting this energy bin into two parts with photon indices of 1.5 and 3.5, respectively. The assumed slopes are indicated in Fig. 2. The results derived by the VERITAS Collaboration on the two sources are also shown for comparison (gray dashed lines). They correspond to 99% C.L. integral flux upper limits of 8.68×10^{-13} cm^{-2} s^{-1} for 4U 0142+61 and 2.49×10^{-12} cm^{-2} s^{-1} for 1E 2259+586 by assuming a power-law with a photon index of 2.5 above 400 GeV (Guenette et al. 2009). The upper limits for both sources are compatible with a break in the power law at ~1 MeV. However, the SED lacks any measurements above hard X-rays, what gives complete freedom under the corresponding instrumental sensitivity.

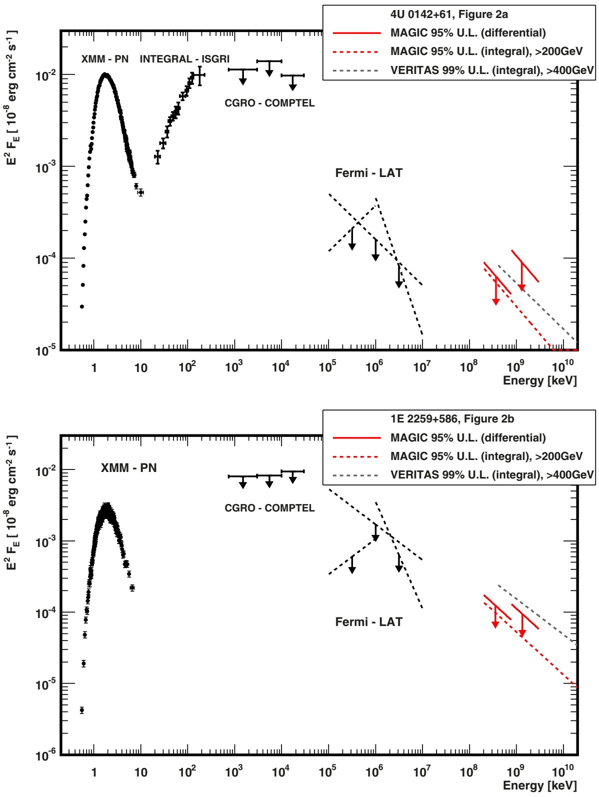

Fig. 2. Spectral energy distributions of 4U 0142+61 **a)** and 1E 2259+586; **b)** from X-rays to TeV energies. In black the points and upper limits in the keV up to the GeV energy range are shown. The upper limits derived by the VERITAS Collaboration are shown in gray and the upper limits from this work are shown in red. See text for further details on the data and upper limits presented here.

Cheng & Zhang (2001) presented a model for the VHE radiation from magnetars. They predicted emission of γ-rays in the GeV band coming from the outer gap for the two sources we studied. This model has been recently revised by Tong et al. (2011), who updated the observational parameters to calculate the γ-ray radiation properties of all AXPs and SGRs using the models by Zhang & Cheng (1997) and Cheng & Zhang (2001). The scenario by Tong et al. (2011) predicts that 4U 0142+61 should have been detected by *Fermi*-LAT, although they explain the lack of a detection by *Fermi*-LAT (Abdo et al. 2010; Şaşmaz Muş & Göğüş 2010) by invoking accretion. For 1E 2259+586 the model does not predict GeV emission. We note that although none of the current models predict TeV range emission for either magnetar, the existence of diffuse emission around 1E 2259+586 could lead to the appearance of an extra component in the SED besides any magnetospheric emission.

Using the MAGIC telescopes we studied for the first time the possibility of magnetars to be a new TeV source class on the examples of 4U 0142+61 and 1E 2259+586. This exploratory work led to a non-detection of the VHE gamma-ray emission from either of them. This result indicates that magnetars are probably not VHE emitters during their quiescent state, as expected from the various theoretical models. However, the possibility of magnetars being VHE emitters during flaring episodes cannot be ruled out because of the lack of VHE observations during these high-activity periods. Consequently, our future searches for VHE emission of magnetars will be performed during outbursts[3].

Acknowledgements. We would like to thank the Instituto de Astrofísica de Canarias for the excellent working conditions at the Observatorio del Roque de los Muchachos in La Palma. The support of the German BMBF and MPG, the Italian INFN, the Swiss National Fund SNF, and the Spanish MICINN is gratefully acknowledged. This work was also supported by the CPAN CSD2007-00042 and MultiDark CSD2009-00064 projects of the Spanish Consolider-Ingenio 2010 programme, by grant DO02-353 of the Bulgarian NSF, by grant 127740 of the Academy of Finland, by the DFG Cluster of Excellence "Origin and Structure of the Universe", by the DFG Collaborative Research Centers SFB823/C4 and SFB876/C3, and by the Polish MNiSzW grant 745/N-HESS-MAGIC/2010/0.

References

Abdo, A. A., Ackermann, M., Ajello, M., et al. 2010, ApJ, 725, L73
Albert, J., Aliu, E., Anderhub, H., et al. 2008, ApJ, 674, 1037
Aleksić, J., Alvarez, E. A., Antonelli, L. A., et al. 2012, Astropart. Phys., 35, 435
Cheng, K. S., & Zhang, L. 2001, ApJ, 562, 918
den Hartog, P. R., Hermsen, W., Kuiper, L., et al. 2006, A&A, 451, 587
den Hartog, P. R., Kuiper, L., Hermsen, W., et al. 2008, A&A, 489, 245
Duncan, R. C., & Thompson, C. 1992, ApJ, 392, L9
Gavriil, F. P., & Kaspi, V. M. 2002, ApJ, 567, 1067
Gavriil, F. P., Dib, R., & Kaspi, V. M. 2011, ApJ, 736, 138
Gonzalez, M. E., Dib, R., Kaspi, V. M., et al. 2010, ApJ, 716, 1345
Guenette, R., et al. 2009 (VERITAS Collaboration), in Proc. 31st ICRC (Łodz) `[arXiv:0908.0717]`
Harding, A. K., & Lai, D. 2006, Rep. Progr. Phys., 69, 2631
Içdem, B., Baykal, A., & Inam, S. Ç. 2012, MNRAS, 419, 3109
Israel, G. L., Mereghetti, S., & Stella, L. 1994, ApJ, 433, L25
Israel, G. L., Oosterbroek, T., Angelini, L., et al. 1999, A&A, 346, 929
Kaspi, V. M., Gavriil, F. P., Woods, P. M., et al. 2003, ApJ, 588, L93
Kuiper, L., Hermsen, W., den Hartog, P. R., & Collmar, W. 2006, ApJ, 645, 556
Li, T.-P., & Ma, Y.-Q. 1983, ApJ, 272, 317
McGill Pulsar Group 2012, McGill SGR/AXP Online Catalog, `http://www.physics.mcgill.ca/~pulsar/magnetar/main.html`
Mereghetti, S. 2008, A&ARv, 15, 225
Moralejo, A., Gaug, M., Carmona, E., et al. 2009, in Proc. 31st ICRC (Łodz) `[arXiv:0907.0943]`
Patel, S. K., Kouveliotou, C., Woods, P. M., et al. 2003, ApJ, 587, 367
Rea, N., & Esposito, P. 2011, in High-Energy Emission from Pulsars and their Systems, eds. D. F. Torres, & N. Rea, 247
Rea, N., Nichelli, E., Israel, G. L., et al. 2007a, MNRAS, 381, 293
Rea, N., Turolla, R., Zane, S., et al. 2007b, ApJ, 661, L65
Rea, N., Esposito, P., Turolla, R., et al. 2010, Science, 330, 944
Rea, N., Israel, G. L., Esposito, P., et al. 2012, ApJ, 754, 27
Rolke, W. A., López, A. M., & Conrad, J. 2005, Nucl. Instr. Meth. Phys. Res. A, 551, 493
Rowell, G., et al. 2011, for the H.E.S.S. Collaboration, Phases of Late Stage Stellar Evolution, Macquarie Univ. Sydney 5–7 Dec.
Şaşmaz Muş, S., & Göğüş, E. 2010, ApJ, 723, 100
Schönfelder, V. 2004, New Astron. Rev., 48, 193
Thompson, C., & Duncan, R. C. 1993, ApJ, 408, 194
Thompson, C., & Duncan, R. C. 1995, MNRAS, 275, 255
Thompson, C., & Duncan, R. C. 1996, ApJ, 473, 322
Tong, H., Song, L. M., & Xu, R. X. 2011, ApJ, 738, 31
Vink, J., & Kuiper, L. 2006, MNRAS, 370, L14
White, N. E., Mason, K. O., Giommi, P., et al. 1987, MNRAS, 226, 645
Woods, P. M., & Thompson, C. 2006, Soft gamma repeaters and anomalous X-ray pulsars: magnetar candidates, eds. W. H. G. Lewin, & M. van der Klis, 547
Woods, P. M., Kaspi, V. M., Thompson, C., et al. 2004, ApJ, 605, 378
Zhang, L., & Cheng, K. S. 1997, ApJ, 487, 370
Zhu, W., Kaspi, V. M., Dib, R., et al. 2008, ApJ, 686, 520

[1] IFAE, Edifici Cn., Campus UAB, 08193 Bellaterra, Spain
[2] INAF National Institute for Astrophysics, 00136 Rome, Italy
[3] Università di Siena, and INFN Pisa, 53100 Siena, Italy
[4] Universidad Complutense, 28040 Madrid, Spain
[5] Max-Planck-Institut für Physik, 80805 München, Germany
[6] Inst. de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain
[7] University of Łódź, 90236 Lodz, Poland
[8] Depto. de Astrofísica, Universidad de La Laguna, 38206 La Laguna, Spain
[9] Deutsches Elektronen-Synchrotron (DESY), 15738 Zeuthen, Germany
[10] ETH Zurich, 8093 Zurich, Switzerland
[11] Universität Würzburg, 97074 Würzburg, Germany
[12] Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, 28040 Madrid, Spain
[13] Università di Udine, and INFN Trieste, 33100 Udine, Italy
[14] Institut de Ciències de l'Espai (IEEC-CSIC), 08193 Bellaterra, Spain
e-mail: `hadasch@ieec.uab.es`
[15] Technische Universität Dortmund, 44221 Dortmund, Germany
[16] Croatian MAGIC Consortium, Rudjer Boskovic Institute, University of Rijeka and University of Split, 10000 Zagreb, Croatia
[17] Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain
[18] Tuorla Observatory, University of Turku, 21500 Piikkiö, Finland
[19] Japanese MAGIC Consortium, Division of Physics and Astronomy, Kyoto University, Japan
[20] Inst. for Nucl. Research and Nucl. Energy, 1784 Sofia, Bulgaria
[21] Universitat de Barcelona (ICC/IEEC), 08028 Barcelona, Spain
[22] Università di Padova and INFN, 35131 Padova, Italy
[23] INAF/Osservatorio Astronomico and INFN, 34143 Trieste, Italy
[24] Università dell'Insubria, Como, 22100 Como, Italy
[25] Inst. de Astrofísica de Andalucía (CSIC), 18080 Granada, Spain
[26] Università di Pisa, and INFN Pisa, 56126 Pisa, Italy
[27] ICREA, 08010 Barcelona, Spain
[28] *Now at*: Institut für Experimentalphysik, Universität Hamburg, Germany
[29] *Now at*: École polytechnique fédérale de Lausanne (EPFL), Lausanne, Switzerland
[30] Supported by INFN Padova
[31] *Now at*: KIPAC, SLAC National Accelerator Laboratory, USA
[32] *Now at*: DESY, Zeuthen, Germany
[33] *Now at*: Finnish Centre for Astronomy with ESO (FINCA), University of Turku, Finland

---

[3] In order to provide fast reactions to such events in the future, MAGIC has installed an alert system, which receives alerts provided by several satellites and points the telescopes to the flaring source automatically, as it is also done for observations of Gamma Ray Bursts.