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Title:Millimeter to X-ray flares from Sagittarius A
Authors:Eckart, A. (1); García-Marín, M. (1); Vogel, S.N. (3); Teuben, P. (3); Morris, M.R. (4); Baganoff, F. (5); Dexter, J. (6); Schödel, R. (8); Witzel, G. (1); Valencia-S., M. (1); Karas, V. (9); Kunneriath, D. (9); Straubmeier, C. (1); Moser, L. (1); Sabha, N. (1); Buchholz, R. (1); Zamaninasab, M. (2); Muzic, K. (10); Moultaka, J. (11); Zensus, J.A. (2)
Author affiliation:(1) I. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany; (2) Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany; (3) Department of Astronomy, University of Maryland, College Park, MD 20742-2421, United States; (4) Department of Physics and Astronomy, University of California, Los Angeles, CA 90095-1547, United States; (5) Massachusetts Institute of Technology, Kavli Institute for Astrophysics and Space Research, United States; (6) Department of Physics, University of Washington, Seattle, WA 98195-1560, United States; (7) Theoretical Astrophysics Center, Department of Astronomy, University of California, Berkeley, CA 94720-3411, United States; (8) Instituto de Astrofísica de Andalucía (CSIC), Glorieta de la Astronomía S/n, 18008 Granada, Spain; (9) Astronomical Institute AV CR, Czech Republic; (10) Department of Astronomy and Astrophysics, University of Toronto, 50 St. George Street, Toronto, ON M5S 3H4, Canada; (11) IRAP, Université de Toulouse, CNRS, 14 Avenue Edouard Belin, 31400 Toulouse, France
Corresponding author:Eckart, A.(eckart@ph1.uni-koeln.de)
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Abstract:Context. We report on new simultaneous observations and modeling of the millimeter, near-infrared, and X-ray flare emission of the source Sagittarius A* (SgrA*) associated with the super-massive (4 × 10 ⁶ M<inf>⊙</inf>) black hole at the Galactic center. Aims. We study the applicability of the adiabatic synchrotron source expansion model and study physical processes giving rise to the variable emission of SgrA* from the radio to the X-ray domain. Methods. Our observations were carried out on 18 May 2009 using the NACO adaptive optics (AO) instrument at the European Southern Observatory's Very Large Telescope, the ACIS-I instrument aboard the Chandra X-ray Observatory, the LABOCA bolometer at the Atacama Pathfinder EXperiment (APEX), and the CARMA mm telescope array at Cedar Flat, California. Results. The X-ray flare had an excess 2-8 keV luminosity between 6 and 12 × 10³³ erg s⁻¹. The observations reveal flaring activity in all wavelength

bands that can be modeled as the signal from an adiabatically expanding synchrotron self-Compton (SSC) component. Modeling of the light curves shows that the sub-mm follows the NIR emission with a delay of about three-quarters of an hour with an expansion velocity of about v <inf>exp</inf> ∼ 0.009c. We find source component sizes of around one Schwarzschild radius, flux densities of a few Janskys, and spectral indices α of about +1 (S(ν) ∞ ν^{-α}). At the start of the flare, the spectra of the two main components peak just short of 1 THz. To statistically explain the observed variability of the (sub-)mm spectrum of SgrA*, we use a sample of simultaneous NIR/X-ray flare peaks and model the flares using a synchrotron and SSC mechanism. Conclusions. These parameters suggest that either the adiabatically expanding source components have a bulk motion larger than v<inf>exp</inf> or the expanding material contributes to a corona or disk, confined to the immediate surroundings of SgrA*. For the bulk of the synchrotron and SSC models, we find synchrotron turnover frequencies in the range of 300-400 GHz. For the pure synchrotron models, this results in densities of relativistic particles of the order of 10^{6.5} cm ⁻³ and for the SSC models, the median densities are about one order of magnitude higher. However, to obtain a realistic description of the frequency-dependent variability amplitude of SgrA*, models with higher turnover frequencies and even higher densities are required. © 2012 ESO.

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