



Summary of the Galactic center session and closing remarks

Michal Zajaček

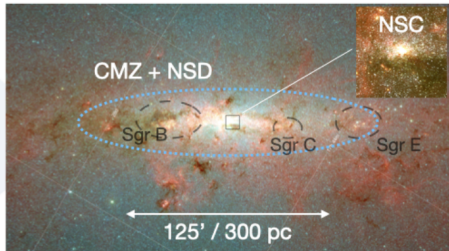
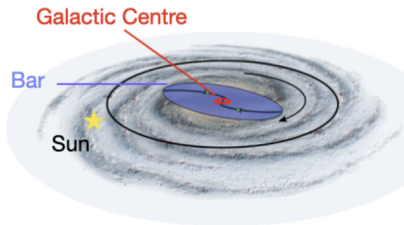
Faculty of Science, Masaryk University

17th Marcel Grossmann Meeting, Pescara

July 12th, 2024

Galactic Center Session summary

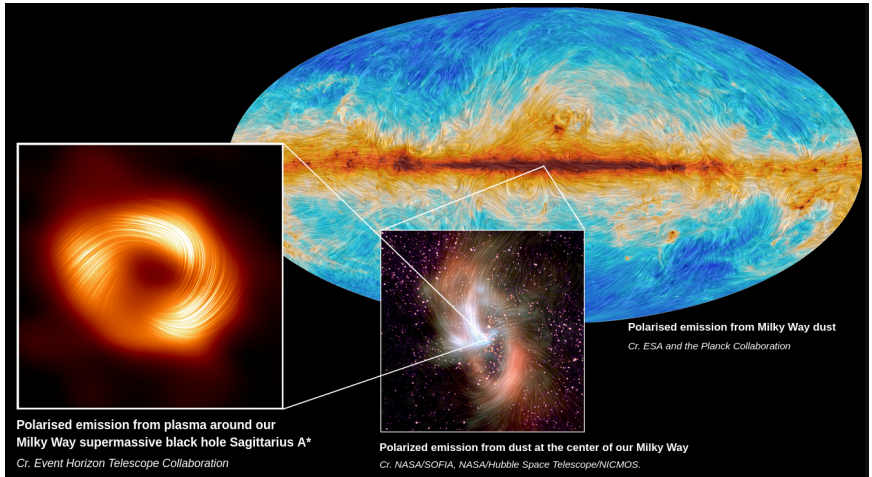
Galactic Center region is crucial to understand the evolution of (not only) the Milky Way



Taken from Schödel et al. (2024)

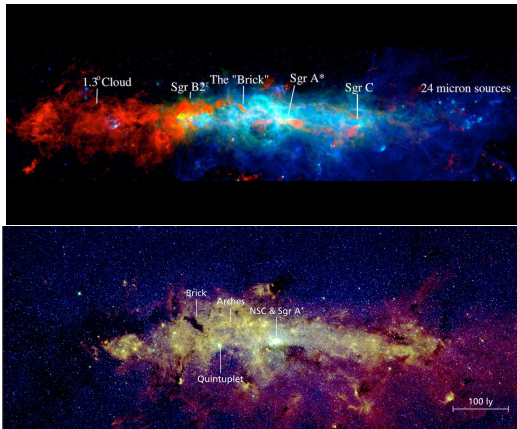
Galactic Center Session summary

We live in an exciting era when we can connect large - Galactic scales to the small- event horizon scales: **10 orders of magnitude**



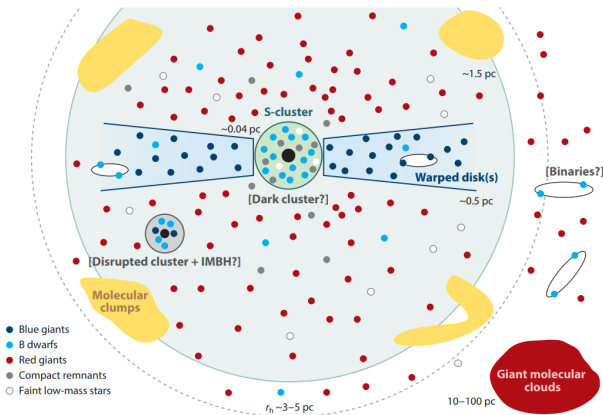
Galactic Center Session summary

Galactic center still remains an irreplaceable laboratory of the nuclear conditions: **interaction of different components: gas of different phases, dust, stars, SMBH**



Galactic Center Session summary

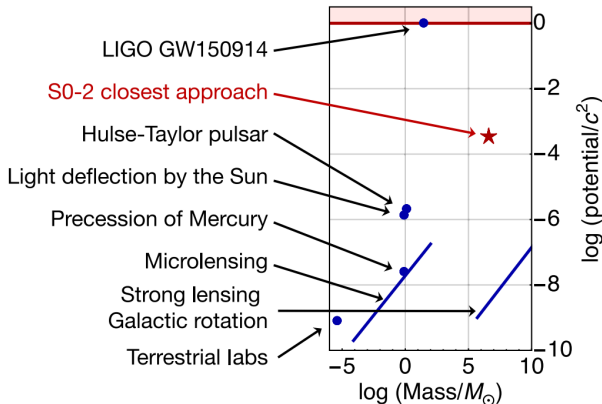
Galactic center still remains an irreplaceable laboratory of the nuclear conditions: **nuclear star cluster dynamics**



See also Alexander (2017)

Galactic Center Session summary

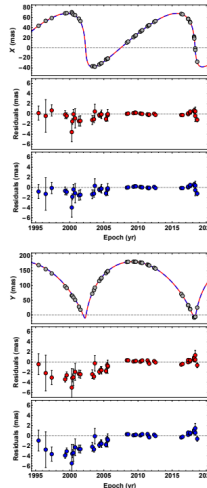
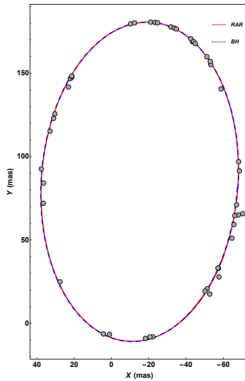
Galactic center still remains an irreplaceable laboratory of the nuclear conditions: **tests of gravitational theories in the strong-gravity regime**



See also Hees et al. (2017)

Take-away concepts – Stellar orbits

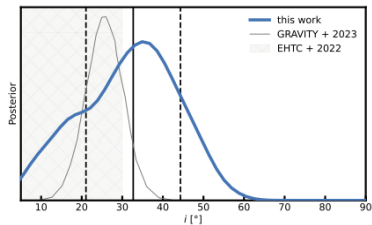
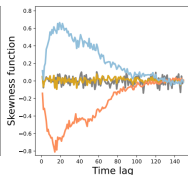
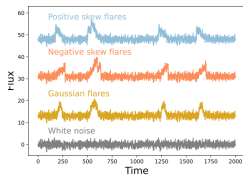
- using **stellar orbits** for tests of alternative theories of Sgr A* and the distribution of (dark) matter (**talks by Harada and Argüelles**)



Becerra-Vergara et al. 2020

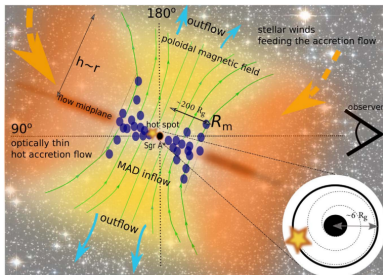
Take-away concepts – Activity of Sgr A*

- we can use dense **NIR/X-ray/submm time series** to study (a)symmetry of flares and study accretion and radiation mechanisms (**talks and papers by von Fellenberg and Goldwurm**)



Take-away concepts – Activity of Sgr A*

- NIR flares are produced by a synchrotron process
- discussion about the X-ray flares (synchrotron-synchrotron with a cooling cutoff or synchrotron - SSC)



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Rapid Variability of Sgr A* across the Electromagnetic Spectrum

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¹⁰Istituto di Radioastronomia—IRAF, Via Paoi Gobetti 101, I-40129, Bologna, Italy

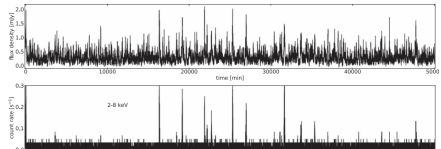
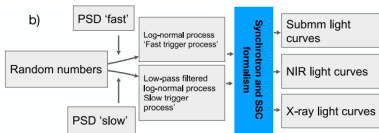
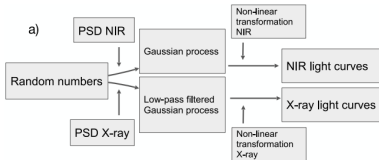
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Abstract

Sagittarius A* (Sgr A*) is the variable radio, near-infrared (NIR), and X-ray source associated with accretion onto the Galactic center black hole. We have analyzed a comprehensive submillimeter (including new observations simultaneous with NIR monitoring), NIR, and 2–8 keV data set. Submillimeter variations tend to lag those in the NIR by ~30 minutes. An approximate Bayesian computation fit to the X-ray first-order structure function shows significantly less power at short timescales in the X-rays than in the NIR. Less X-ray variability at short timescales, combined with the observed NIR–X-ray correlations, means the variability can be described as the result of two strictly correlated stochastic processes, the X-ray process being the low-pass-filtered version of the NIR process. The NIR–X-ray linkage suggests a simple radiative model: a compact, self-absorbed synchrotron sphere with high-frequency cutoff close to NIR frequencies plus a synchrotron self-Compton scattering component at higher frequencies. This model, with parameters fit to the submillimeter, NIR, and X-ray structure functions, reproduces the observed flux densities at all wavelengths, the statistical properties of all light curves, and the time lags between bands. The fit also gives reasonable values for physical parameters such as magnetic flux density $B \approx 13$ G, source size $L \approx 2.2R_g$, and high-energy electron density $n_e \approx 4 \times 10^7$ cm⁻³. An animation illustrates typical light curves, and we make public the parameter chain of our Bayesian analysis, the model implementation, and the visualization code.

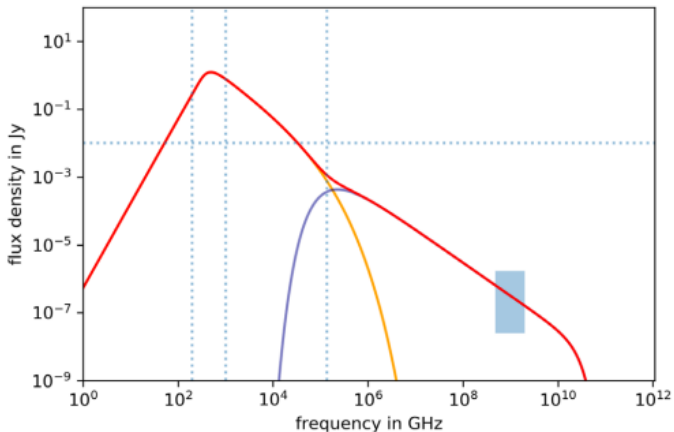
Take-away concepts – Activity of Sgr A*

- Witzel et al. (2021) proposes a model with a one-zone, compact synchrotron self-absorbed sphere to reproduce NIR, X-ray, submm light curves



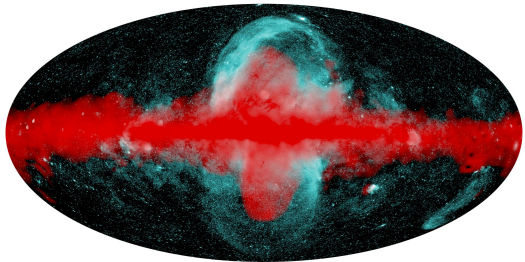
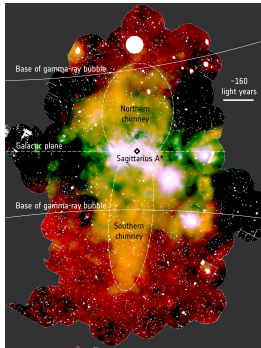
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Take-away concepts – Mapping the central region

- Central Galactic Zone including molecular clouds, bubbles, and cavities can be studied using diffuse X-ray emission (Fe $K\alpha$ variability) – **Talks and papers by Goldwurm, Stel, Zhang**



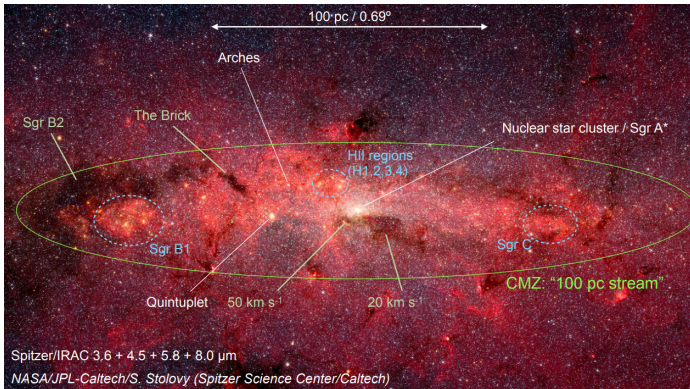
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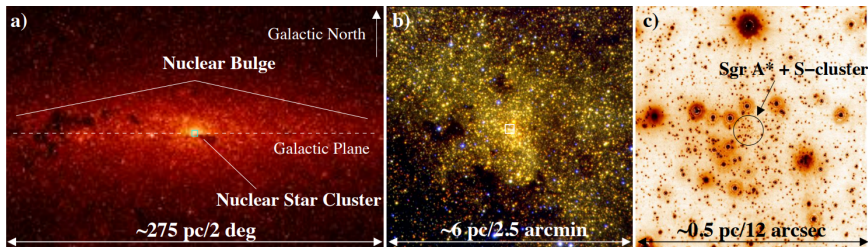
Take-away concepts – Stellar content

- Stellar composition of the central region: elongated Nuclear Stellar Disk, almost spherical Nuclear Stellar Cluster: **see the talks and papers by Feldmeier-Krause, Gallego Cano, and Nogueras Lara et al.**



Take-away concepts – Stellar content

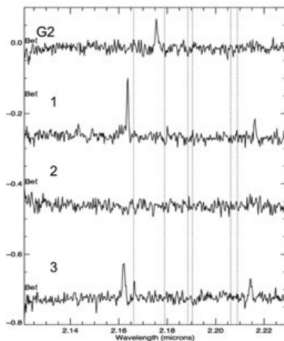
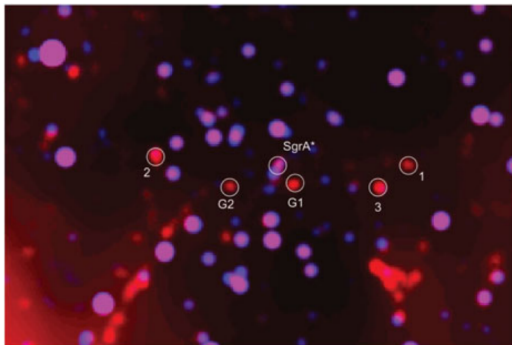
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See also Schödel et al. (2014)

Take-away concepts – Stellar content

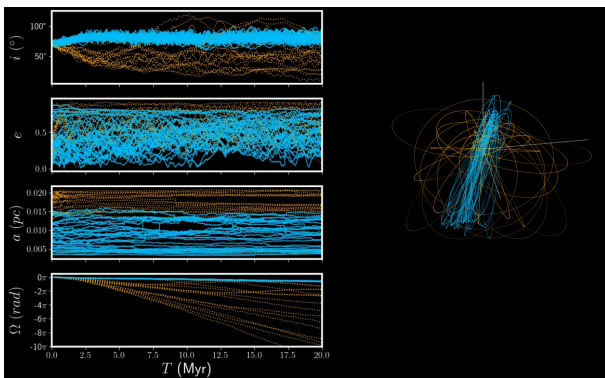
- Within the S cluster, there is a remaining mystery of **G objects/DSOs**: young stars, stellar mergers, or still clouds? **See the talks and papers by Ciurlo, Melamed, and Zajaček et al.**



Taken from Meyer et al. (2014)

Take-away concepts – Stellar content

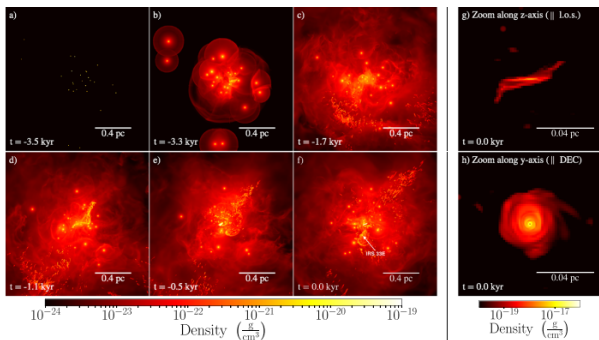
- NSC & S cluster stellar dynamics: evidence of stable disk-like configurations, potentially more disks that can arise due to external perturbations (outer stellar disks or massive perturbers such as an IMBH). **See the talk and paper by Singhal et al.**



Taken from Singhal et al. (2024)

Take-away concepts – Stellar content

- NSC & S cluster magnetohydrodynamics: wind-fed accretion onto Sgr A* and the possibility of a cool-disc formation. See the talk and the papers by Calderon, Ressler et al.



Taken from Calderon et al. (2020)

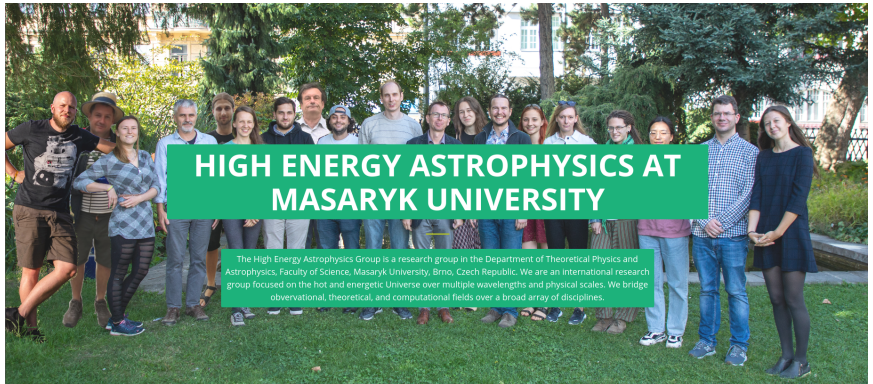
Galactic Center Workshop 2026/2027 in Brno

Letter of Intent for IAU Symposium in prep.



Galactic Center Workshop 2026/2027 in Brno

Hosting (LOC) team - HEA at Masaryk University



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