SSR: Solar System Simulator

Dietmar G. Schrausser

https://github.com/Schrausser/SSR

Overview

Solar System Simulation SSR. Android globus coelestis (celestial globe) and interactive calendar with Zodiac signs and timepiece covering the Solar System in the entire observable Universe up to r = 14.*25 Gpc*.

Contains n = 69 stars, n = 70 nebulae and star clusters, most important Milky Way objects, n = 48 galaxies and galaxy clusters as well as the most well-known quasars. Full implementation of all n = 110 Messier objects (Messier, 1784), Inner Cloud (Hills, 1981), Oort Cloud (Oort, 1950) and more.

Further astronomical objects can be implemented by means of external definition files. All objects of the Caldwell catalogue (Moore & Pepin, 1995) as well as parts of the Herschel 400 catalogue (Mullaney, 1976) are included as *ssr_Caldwell.dat* and *ssr_Herschel400.dat*. For additional important astronomical catalogues see e.g. *CN* (Herschel, 1786) or *NGC* (Dreyer, 1888).

Solar System parameters of the Sun, planets and Moon are based on the current NASA Planetary Fact Sheets (Williams, 2023). Positions, distances and sizes of further objects are from Wikipedia sources (Wikipedia contributors, 2023), which can be traced back primarily to the *SIMBAD* astronomical database (Strasbourg astronomical Data Center, 2023), the *VizieR* Catalogue Service (see Ochsenbein et al., 2000) or the NASA/IPAC Extragalactic Database *NED*.

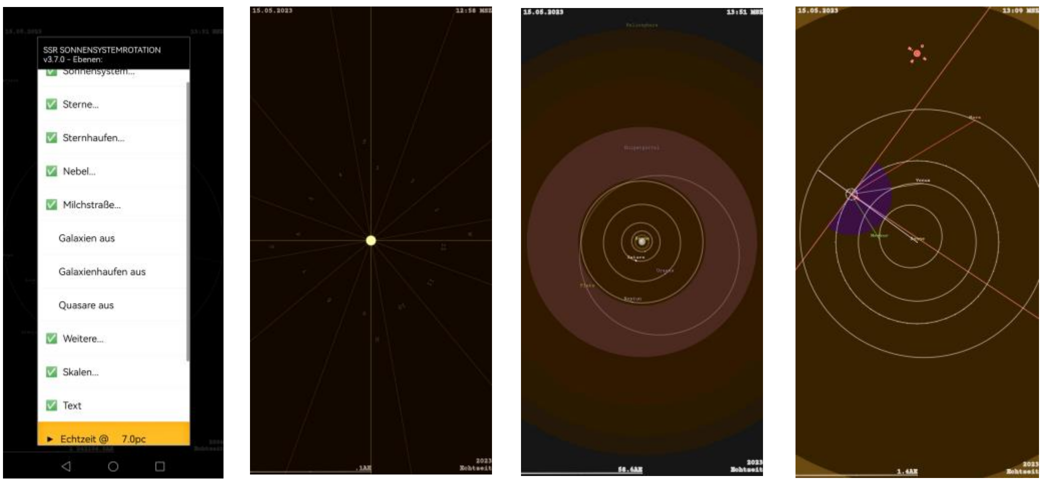

Figure 1: The Sun at r = 0.1 *au* astronomical units; Solar System with Asteroid and Kuiper Belts as well as Heliosphere at r = 58.6 *au*; Inner Solar System with orbits, current rotation position of the Earth with time and position representation, as well as projection lines to the neighboring planets at r = 1.4 *au*.

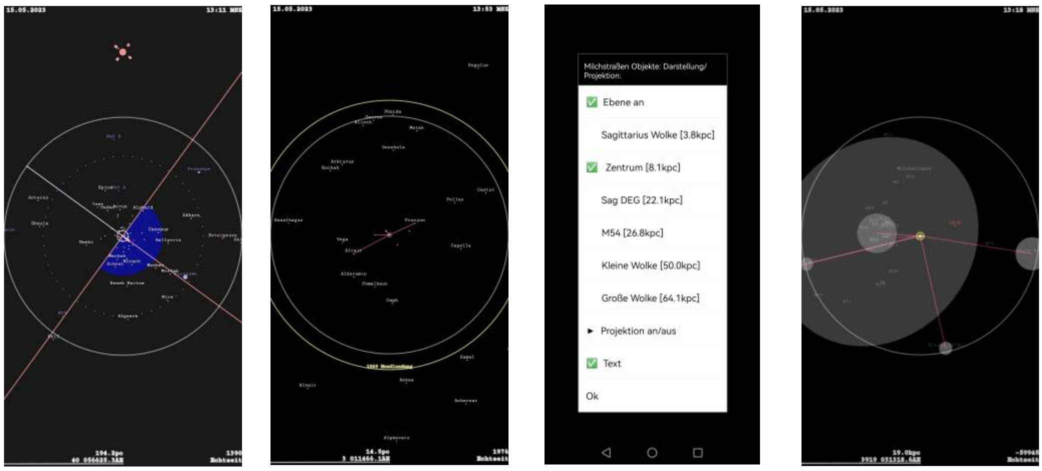

Figure 2: Surrounding stars at *r* = 194.2 *pc* and their relative positions to Earth, artificial horizon facing south; closer stars with their relative historical position and representation, from *r* = 14.5 *pc* before the year 1976; the Milky Way at *r* = 19 *kpc* with Magellanic Clouds, Sagittarius Dwarf Elliptical Galaxy Sag DEG (Ibata et al., 1994) and V838 Monocerotis (Brown et al., 2002).

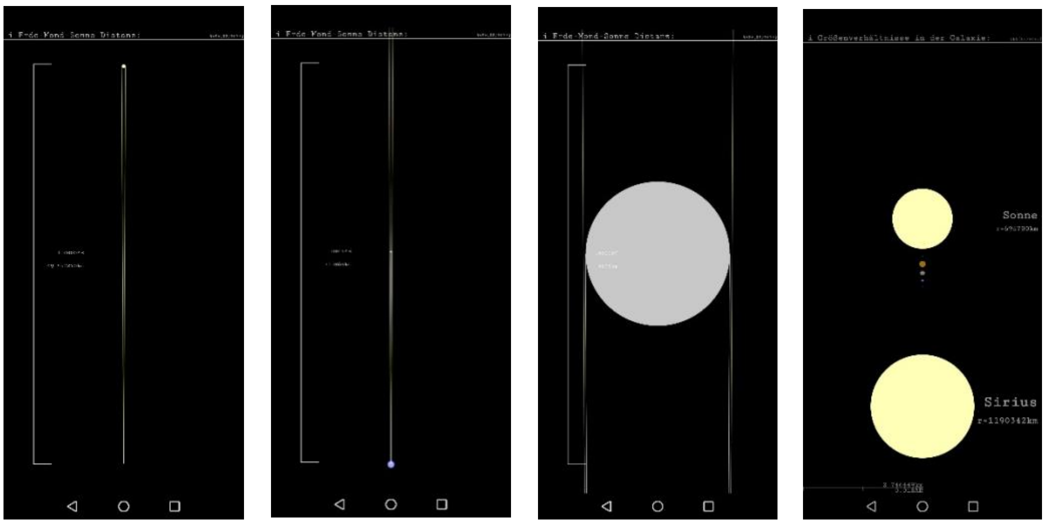

Figure 3: Interactive simulation to display distances between Earth, Moon and Sun with corresponding perspective projection lines; interactive simulation to compare sizes of stars.

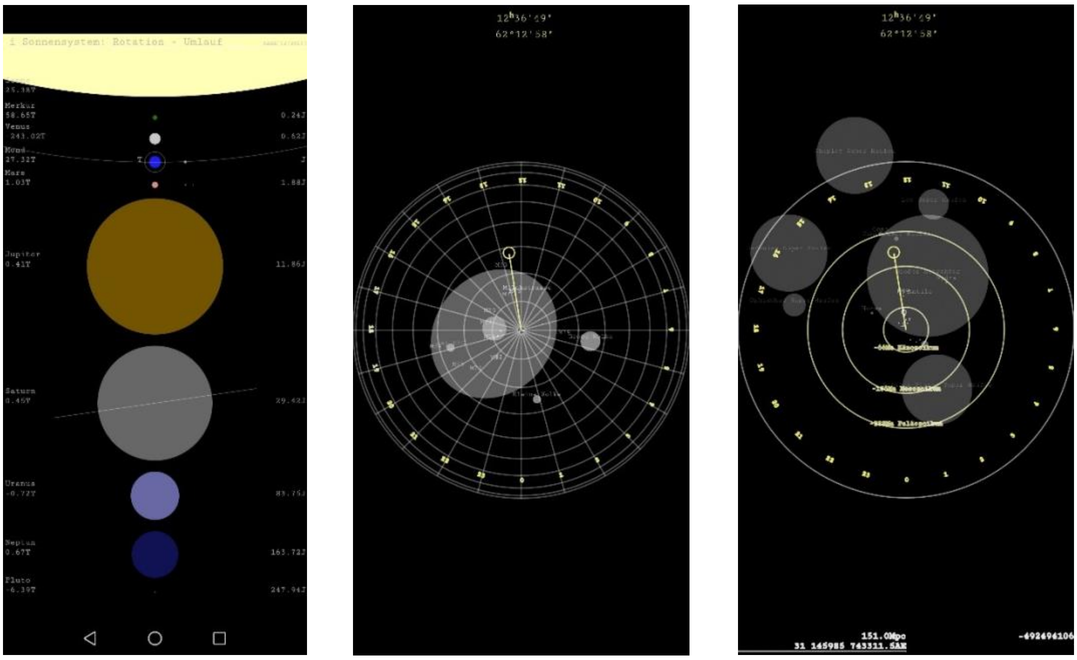

Figure 4: Parameters of the Solar System; Hubble deep field (HDF) located at a right ascension of 12^h 36m 49s and a declination of +62° 12′ 58″ (see Ferguson, 1996); towards the HDF from a distance of $r = 151$ *Mpc* within the surrounding galaxy clusters and Laniakea supercluster (Tully et al., 2014) with relative historical positions.

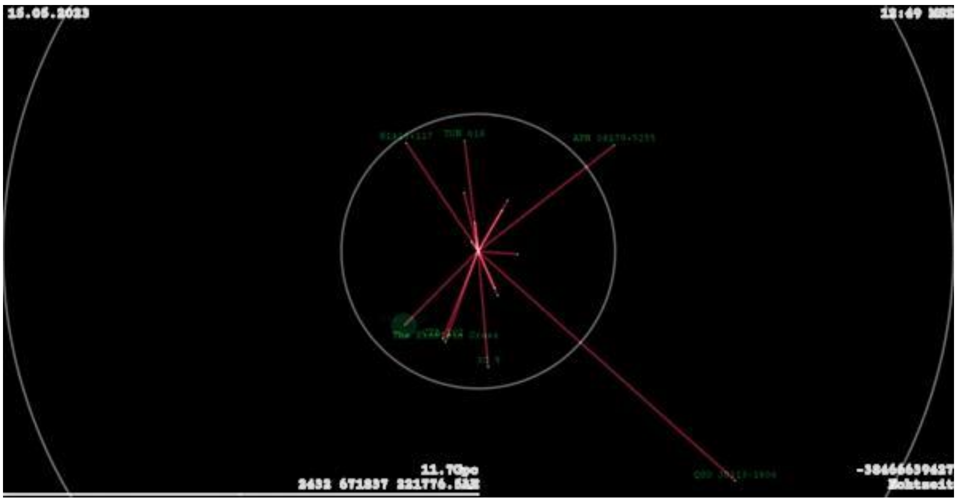

Figure 5: Most distant quasars on the edge of the observable Universe at $r > 9$ *Gpc* (see e.g. Wang et al., 2021).

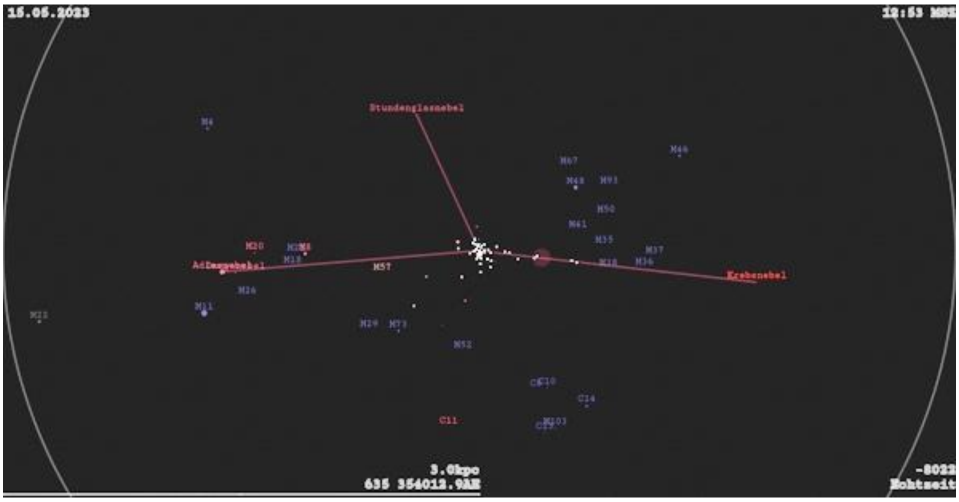

Figure 6: Local star cluster within Orion-Cygnus Arm containing the signs of the Zodiac and surrounding nebulae seen from a distance of r = 3 *kpc*.

Object distances r in parsec *pc* are calculated from parallax π_O, given in milliarc-seconds *mas* with

$$r = (\pi_O/_{1000})^{-1}.$$

The *luminosity* distance $r = d_l$ in parsec *pc* is given by

$$r = 10^{(\mu/5)+1}$$

with distance modulus μ, defined by the difference between apparent magnitude m and absolute magnitude M as

$$\mu = m\text{-}M.$$

Object radii r_O at a given distance r are calculated via angular diameter V^o where

$$r_O = r{\cdot}\tan({}^V/_2);\ V = ({}^{V^o}/_{180}){\cdot}\pi.$$

For more on photometry see e.g. Miles (2006) or Milone (2011).

Acknowledgement

This research has made use of the NASA/IPAC Extragalactic Database (NED), which is funded by the National Aeronautics and Space Administration and operated by the California Institute of Technology. http://ned.ipac.caltech.edu/

References

Brown, N. J., Waagen, E. O., Scovil, C., Nelson, P., Oksanen, A., Solonen, J., & Price, A. (2002). Peculiar variable in Monoceros. *International Astronomical Union Circular, 7785*, 1. https://ui.adsabs.harvard.edu/abs/2002IAUC.7785....1B

Dreyer, J. L. E. (1888). A New General Catalogue of Nebulae and Clusters of Stars, being the Catalogue of the late Sir John F. W. Herschel, Bart., revised, corrected, and enlarged. *Memoirs of the Royal Astronomical Society, 49*, 1—237. https://ui.adsabs.harvard.edu/abs/1888MmRAS..49....1D

Ferguson, H. (1996). *The Hubble Deep Field – field selection*. Space Telescope Science Institute.

Herschel, W. (1786). Catalogue of One Thousand New Nebulae and Clusters of Stars. *Philosophical Transactions of the Royal Society of London, 76*, 457—499. https://doi.org/10.1098%2Frstl.1786.0027

Hills, J. G. (1981). Comet showers and the steady-state infall of comets from the Oort Cloud. *Astronomical Journal, 86*, 1730—1740. https://doi.org/10.1086%2F113058

Ibata, R. A., Gilmore, G., & Irwin, M. J. (1994). A dwarf satellite galaxy in Sagittarius. *Nature, 370*, 194—196. https://doi.org/10.1038%2F370194a0

Messier, C. (1784). *Cataloque des nébuleuses et amas d'étoiles, La Connaissance des temps, ou connaissance des mouvements célestes, pour l'année bissextile 1784*. Paris, Imprimerie royale, 1781, p. 227—267. http://www.messier-objects.com

Miles, R. (2006). A light history of photometry: from Hipparchus to the Hubble Space Telescope. *Journal of the British Astronomical Association, 117*(4), 172—186. https://ui.adsabs.harvard.edu/abs/2007JBAA..117..172M

Milone, E. F. (2011). *Astronomical Photometry: Past, Present and Future.* New York: Springer. https://archive.org/details/astronomicalphot00milo

Moore, P., & Pepin, M. B. (1995). Beyond Messier: The Caldwell Catalogue. *Sky and Telescope* Vol. 90, Cambridge, MA. http://www.messier.seds.org/xtra/similar/caldwell.html

Mullaney, J. (1976). Letter to Sky & Telescope. *Sky & Telescope*, 235, Cambridge, MA. https://web.archive.org/web/20071001004725

Ochsenbein, F., Bauer, P., & Marcout, J. (2000). The VizieR database of astronomical catalogues. *Astronomy and Astrophysics Supplement Series, 143*, 23—32. https://doi.org/10.1051/aas:2000169

Oort, J. H. (1950). The Structure of the Cloud of Comets Surrounding the Solar System and a Hypothesis Concerning its Origin. *Bulletin of the Astronomical Institutes of the Netherlands, 11*, 91—110. https://ui.adsabs.harvard.edu/abs/1950BAN....11...91O/abstract

Strasbourg astronomical Data Center. (2023). *SIMBAD, Set of Identifications, Measurements and Bibliography for Astronomical Data*. CDS. STRASBOURG, France. http://cdsweb.u-strasbg.fr/Simbad.html

Tully, R. B., Courtois, H., Hoffman, Y., & Pomarède, D. (2014). The Laniakea supercluster of galaxies. *Nature, 513*, 71—73. https://doi.org/10.1038/nature13674

Wang, F., et al. (2021). A Luminous Quasar at Redshift 7.642. *The Astrophysical Journal, 907*(1), L1. https://doi.org/10.3847%2F2041-8213%2Fabd8c6

Wikipedia contributors. (2023). *Wikipedia, The Free Encyclopedia*. Retrieved May 2023 from https://www.wikipedia.org

Williams, D. R. (2023). *Planetary Fact Sheet*. NASA Goddard Space Flight Center. https://nssdc.gsfc.nasa.gov/planetary/factsheet/