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Siril: An Advanced Tool for Astronomical Image Processing

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


1 Siril: An Advanced Tool for Astronomical Image 2 Processing

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8 Summary

9 Siril is a powerful open-source software package designed for the preprocessing and post-
10 processing of astronomical images. It is particularly well-suited for astrophotography enthusiasts
11 and professional astronomers alike. Siril provides advanced tools for tasks such as image stacking,
12 calibration, registration, and enhancement, enabling users to produce high-quality images of
13 celestial objects. The version discussed here is the development branch 1.4, which, while not
14 officially released, is available for testing and includes the latest features and improvements.

Statement of Need

15 Astronomical imaging requires specialized software capable of handling the unique challenges
16 presented by the data. Siril addresses these challenges by providing a suite of tools designed to
17 process images from various types of astronomical instruments. Its robust feature set includes
18 support for multiple image formats and precise photometric calibration techniques.

19 Siril stands out for its user-friendly interface and integration with other astronomical software
20 packages. It offers a comprehensive solution for both amateur and professional astronomers
21 to enhance their imaging workflows. The software has been utilized in numerous scientific
22 publications and astrophotography projects, demonstrating its versatility and effectiveness.

23 There are many solutions available for astronomical imaging, but few are open source. For
24 example, IRIS was a popular tool but has not been developed since 2005. Another well-known
25 software, IRAF, consists of 40-year-old legacy code, and institutional support for IRAF and its
26 usage is rapidly declining. It is recommended to search for alternative solutions, such as those
27 in the Astropy community, and to avoid starting new projects using IRAF ([Ogaz et al., 2018](#)).
28 Siril fills this gap by providing a modern, open-source alternative that continues to evolve and
29 support the needs of the astronomical community.

31 Features and Functionality

32 Siril provides a range of features to support astronomical image processing:

- 33 ▪ **Image Calibration:** Correction of biases, darks, and flats to calibrate astronomic images
34 data.
- 35 ▪ **Image Registration and Stacking:** Alignment of images taken at different times and their
36 subsequent stacking to increase signal-to-noise ratio. In last version it also incorporates
37 the Hubble Space Telescope drizzle algorithm ([Fruchter & Hook, 2002](#)) for applying

38 WCS (World Coordinate System) and registration data transforms, providing improved
39 detail reconstruction when processing sets of under sampled images.

- 40
- 41 ▪ **Advanced Image Enhancement:** Application of various filters and algorithms to improve
42 image details and reduce noise. For example, the Larson-Sekanina filter is particularly
43 useful for highlighting non-circular structures in images of comets by enhancing radial
44 features and making structures like jets and dust trails more visible (Larson & Sekanina,
1984). An example of such a filter applied to a comet image is given in Figure 1.

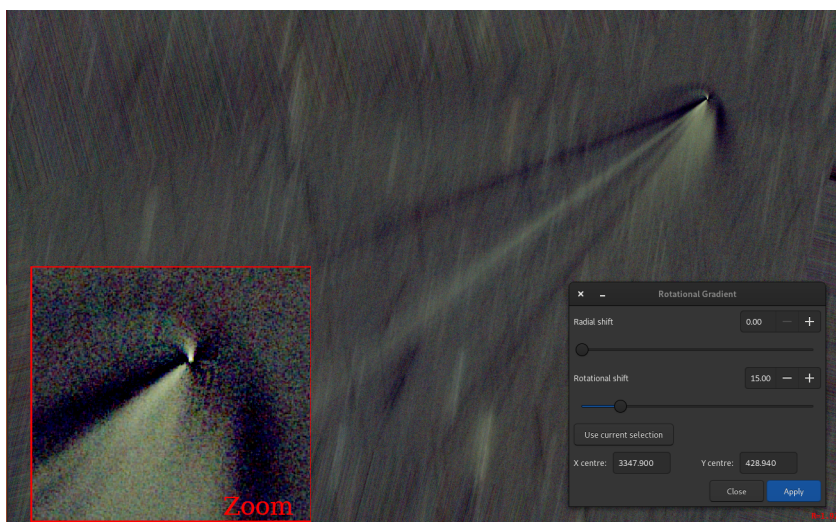


Figure 1: Application of the Larson Sekanina filter on a comet image to highlight non-circular structures in the image.

- 45
- 46 ▪ **Astrometry:** Precise measurement and analysis of the positions and movements of
47 celestial objects within the images. Siril includes functionalities for astrometric calibration,
48 allowing users to solve astrometric fields and match observed star and solar system object
49 positions with reference catalogs. It uses the WCS (World Coordinate System) features
50 from FITS file keywords (Calabretta et al., 2004; Calabretta & Greisen, 2002; Greisen &
Calabretta, 2002).
 - 51 ▪ **Spectro Photometric Calibration:** Accurate calibration of image photometry using the
52 latest version of the Gaia catalog (Gaia Collaboration et al., 2023) for recovering the
53 true colors of astronomical objects in the images.
 - 54 ▪ **Photometry:** Capability to perform photometric analysis, including the creation of light
55 curves for variable stars and the observation of exoplanet transits.
 - 56 ▪ **Scriptability:** Ability to automate repetitive tasks through scripting, increasing efficiency.
- 57 These are just a selection of the many features Siril offers. The number of functionalities is
58 significantly larger and continuously growing as the software evolves.

59 FreeAstro Ecosystem

60 The FreeAstro ecosystem encompasses various projects and repositories that support and extend
61 the functionality of Siril. FreeAstro, hosted on GitLab, serves as the umbrella organization for all
62 projects related to Siril, fostering a collaborative environment for development, documentation,
63 and community engagement.

- 64 ▪ [siril-web](#): The official website for Siril¹, built using the open-source static site generator
65 Hugo and hosted by pixls.us², which also hosts forums for open-source image processing
66 software. This site provides users with access to the latest news, updates, and resources
67 related to Siril.
- 68 ▪ [siril-doc](#): The documentation repository, utilizing Read the Docs for hosting. This
69 repository contains comprehensive user manuals, guides, and reference materials to assist
70 users in effectively utilizing Siril's features. There are two branches available: one for
71 the stable version³ and one for the development version⁴.
- 72 ▪ [siril-localized-doc](#): Dedicated to the translation of Siril's documentation. This repository
73 leverages Weblate, a translation platform, to support multiple languages and ensure that
74 documentation is accessible to a global audience.
- 75 ▪ [siril-spcc-database](#): This repository stores data related to the Spectro Photometric Color
76 Calibration (SPCC) tool. It includes JSON files detailing OSC/monochrome sensors and
77 filters available on the market. The primary goal of this database is to collect extensive
78 data and promote collaboration within the astronomy community.
- 79 ▪ [siril-scripts](#): A repository where users can share and contribute scripts that extend Siril's
80 functionality. These user-contributed scripts are integrated into Siril, providing additional
81 tools and capabilities for the community.

82 **Acknowledgements**

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84 testers and users who provided invaluable feedback. We also extend our gratitude to François
85 Meyer, who initiated the project over 20 years ago. Additionally, we thank the team at pixls.us
86 for generously hosting our website and forums, supporting the open-source image processing
87 community.

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