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Astellum: A Morphological Feature Annotation Tool for Astronomy Outreach

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SCAN FOR THE CODE

github.com/AmyYingTang/astellum

Plate-solving can already name the objects in an astrophotograph [1] — but not the **morphological features** within them, nor explain them to **each viewer** [7].

01 Input image

02 Plate-solve [1]

① FEATURE TRANSFER

More than a name

03 Catalogues
SIMBAD [9] · VizieR [10] · OpenNGC
catalogued target names and properties

04 Feature atlas
morphological features, in ICRS
target-specific astronomical details

05 Reproject from ICRS [2] [3]
ICRS polygons → pixel positions via the image's WCS

06 Annotated image

② AI-ASSISTED READINGS

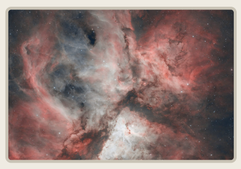
Tailored to each viewer

Vision–language models infer content from pixels [4], which is unreliable for astronomical images [5]. Here the LLM is given only the results of 03–04.

07 Readings for each audience
Primary student · Adult · Teacher
LLM, grounded in the feature list [8]

08 Poster
human-reviewed

01 · INPUT IMAGE



CARINA NEBULA · NGC 3372
As photographed, without annotations.

04 · ONE ATLAS RECORD, EXCERPTED

```
{ "primary_id": "NGC 3372",
  "annotations": [{
    "id": "anno_mvkuvwli",
    "feature_type": "pillar",
    "geometry": { "type": "polygon",
      "vertices": [[161.70262708550467, -60.22995468969956],
        [161.70924367763155, -60.21207156491492], …] },
    "label": { "en": "Pillar" },
    "status": "approved",
    "author": "amy", "reviewed_by": "sam" }] }
```

HOW THE TRANSFER WORKS

Purely geometric: unaffected by colour palette, mirroring, rotation, cropping or plate scale. No model training. A **seed atlas**, growing, open to community contributions.

06 · ANNOTATED IMAGE



Same frame after step 05; labels come from atlas records, not drawn by hand.

07 · ONE PILLAR, THREE AUDIENCES — ASTELLUM OUTPUT, EXCERPTED [6]

PRIMARY SCHOOL STUDENTS

This pillar looks like a tall tower, or a finger poking out of the cloud. … a baby star might be hiding there!

ADULTS

This pillar is a knot of gas and dust denser than its surroundings … standing like a rock column carved by wind. …

SECONDARY SCIENCE TEACHERS

This pillar is a column of dense gas and dust left standing after ultraviolet radiation and stellar winds … Curriculum link: gravity versus radiation. …

ONE PIPELINE, THREE MODES · ONLINE OR OFFLINE

Kiosk Public observing nights: runs the whole flow (01 → 08) on fresh frames or visitor uploads.

Studio Fine-grained annotation, reading review and editing (the human check on 07), poster generation (08).

Atlas Atlas management: builds and reviews the records behind 04; open to community-contributed features.

Status

Under active development; all three modes in place. Evaluation with school groups is planned. **Come and talk to me** about atlas contributions or classroom use — feedback very welcome.

References

[1] Lang D. et al. 2010, AJ, 139, 1782
[2] Calabretta M. R. & Greisen E. W. 2002, A&A, 395, 1077
[3] Astropy Collaboration 2022, ApJ, 935, 167
[4] Zaman S. et al. 2025, arXiv:2504.08583
[5] Dhar S. & Shamir L. 2022, arXiv:2201.03131
[6] Fouesneau M. et al. 2024, arXiv:2409.20252
[7] Iovenitti S. et al. 2021, arXiv:2108.08032
[8] Lewis P. et al. 2020, NeurIPS, 33, 9459
[9] Wenger M. et al. 2000, A&AS, 143, 9
[10] Ochsenbein F., Bauer P. & Marcout J. 2000, A&AS, 143, 23
OpenNGC: M. Verga, github.com/mattiaverga/OpenNGC

Astronomical **S**tructure **T**agging, **E**xplanation and **L**evel-adaptive **L**earning for **U**nderstanding **M**orphology

Atlas annotations reviewed by Junsheng He.
Readings generated with Claude (Anthropic); software development and poster drafting also assisted by Claude.

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