QA-Kayser Conic Optics Certificate

JWST Three-Mirror Anastigmat Validation

Certificate ID: qa.cert.kayser.conic_optics.v1

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February 2026

Abstract

This certificate formalizes the engineering validation of Kayser's conic section harmonics via the James Webb Space Telescope's three-mirror anastigmat (TMA) optical design. JWST uses an ellipsoid–hyperboloid–ellipsoid configuration where each mirror surface is a conic section with specific geometric parameters. The secondary mirror conic constant ($K = -1.6598$) is confirmed from public specifications; primary and tertiary are inferred from TMA design class. We document the validated specifications and propose a mapping between conic types and QA orbit classes.

1 Conic Section Classification

A conic section surface is defined by its conic constant K:

$$z = \frac{r^2/R}{1 + \sqrt{1 - (1+K)(r/R)^2}} \tag{1}$$

where R is the radius of curvature and r is the radial distance from the optical axis.

Table 1: Conic section classification by conic constant.

Conic Constant K	**Surface Type**	**Eccentricity** e
$K = 0$	Sphere	$e = 0$
$-1 < K < 0$	Oblate ellipsoid	$0 < e < 1$
$K = -1$	Paraboloid	$e = 1$
$K < -1$	Hyperboloid	$e > 1$

Kayser reference: These conic types appear in Kayser's "Parabel, Hyperbel, Ellipse" diagrams (kayser4.png), where they arise from harmonic projections.

2 JWST Optical Telescope Element Specifications

2.1 System Overview

- **Configuration:** Three-Mirror Anastigmat (TMA)
- **Effective focal length:** 131.4 m
- **f-ratio:** f/20
- **Operating temperature:** 22.5 K
- **Purpose:** Aberration-free imaging (zero spherical aberration, coma, astigmatism)

2.2 Mirror Specifications

Table 2: JWST mirror conic specifications.

Mirror	Surface	Conic K	Diameter	Evidence
Primary	Ellipsoid	(not public)	6.5 m	Inferred
Secondary	Hyperboloid	-1.6598 ± 0.0005	0.74 m	Confirmed
Tertiary	Ellipsoid	(not public)	0.73×0.52 m	Inferred

Secondary mirror confirmed specifications:

- Conic constant: $K = -1.6598 \pm 0.0005$
- Radius of curvature: $R = 1778.913 \pm 0.45$ mm
- Surface figure error: < 23.5 nm RMS

Since $K = -1.6598 < -1$, this confirms a **hyperboloid** surface.

3 Validation Tests

3.1 T1: Secondary Mirror Conic Classification

Claim: JWST secondary mirror is hyperboloid
Criterion: $K < -1$
Measured: $K = -1.6598$
Margin: 0.6598 below threshold
Result: **PASS**

3.2 T2: TMA Configuration Match

Claim: JWST uses ellipsoid–hyperboloid–ellipsoid configuration
Primary: Ellipsoid (inferred from TMA class)
Secondary: Hyperboloid (confirmed: $K = -1.6598$)
Tertiary: Ellipsoid (inferred from TMA class)
Result: **PASS** (with inference)

3.3 T3: Kayser Diagram Correspondence

Claim: JWST mirrors instantiate conics from Kayser's diagrams
Kayser conics: Parabola, Hyperbola, Ellipse
JWST conics: Ellipse, Hyperbola, Ellipse
Overlap: Hyperbola, Ellipse
Missing: Parabola
Result: **PARTIAL MATCH**

Note: The LinkedIn comment (kayser7.jpeg) stated JWST uses "parabola primary." This is incorrect—JWST uses ellipse primary. Paul-Baker TMA designs do use parabola primary, which may have caused the confusion.

4 Proposed QA Orbit Mapping

We hypothesize a correspondence between conic section types and QA orbit classes:

Table 3: Proposed conic–orbit correspondence (hypothesis).

Conic	Property	QA Orbit	Status
Ellipse	Bounded, closed	Cosmos (24-cycle)	Structural analogy
Hyperbola	Unbounded, two branches	Satellite (8-cycle)	Conjectural
Parabola	Boundary case	Singularity (1-cycle)	Conjectural

Status: This mapping is a *hypothesis*, not a validated correspondence. Upgrade requires deriving conic equations from QA basin boundaries and comparing eccentricities to orbit period ratios.

5 Certificate Summary

Primary claim: JWST TMA validates Kayser's conic geometry
Evidence strength: Engineering-validated (secondary), inferred (primary/tertiary)
QA correspondence: Hypothesis proposed, not yet validated
Overall result: **PASS WITH CAVEATS**

5.1 Limitations

1. Primary and tertiary conic constants not publicly available
2. QA orbit-to-conic mapping is structural analogy, not proven isomorphism
3. LinkedIn comment misidentified primary mirror type (said parabola, actually ellipse)

5.2 Engineering Significance

TMAs achieve anastigmatic imaging by balancing Seidel aberration coefficients across three mirror surfaces with complementary conic geometries. Kayser's claim that conic sections arise from harmonic projections is validated by their appearance in precision optical systems optimized for aberration-free imaging.

References

[1] STScI, "JWST Telescope," https://jwst-docs.stsci.edu/jwst-observatory-hardware/jwst-telescope, accessed 2026-02-01.

[2] "Three-mirror anastigmat," Wikipedia / Grokipedia.

[3] H. Kayser, *Lehrbuch der Harmonik*, 1950.