Solar Na appendix

Sun · Na · downloadable appendix

Document	Solar Na appendix
Subject	Solar photospheric abundance appendix · Na
Author	Ryan Schmitt
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Solar sodium: 6.313 ± 0.039

Asplund, Amarsi & Grevesse 2021: 6.22 ± 0.03 · this measurement +0.093 dex

The three-dimensional non-LTE products apply published line-by-line corrections (Asplund et al. 2021; Canocchi et al. 2026) to our one-dimensional fits; they are not our own three-dimensional calculation. The H- and K-band products sit about 0.4 dex below the visible ones. They are shown as measured, with their full error bars.

Measured the way Asplund, Amarsi & Grevesse (2021) measure it: the Asplund et al. 2021 line set (the five Na I lines of their Table A.1), 5 lines measured on one spectrum, each part weighted by its uncertainty.

Na I: 6.291 ± 0.048 · Kitt Peak (1984, molecfit) · VIS · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi)

Na I: 6.328 ± 0.040 · Kitt Peak (1984, molecfit) · NIR · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi)

Highlighted Products

near-UV

6.671 ± 0.141

Na I · Deep-graded lines · 1D NLTE (Gerber) · Kitt Peak (Kurucz 2005) · Deep Grade

VIS

6.287 ± 0.047

Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · Kitt Peak (Kurucz 2005) · Reference Grade

red-optical

6.338 ± 0.091

Na I · Codex-graded lines · 1D NLTE (Gerber) · Kitt Peak (1984, molecfit) · Codex Grade

NIR

6.328 ± 0.040

Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · Kitt Peak (1984, molecfit) · Reference Grade

H

5.779 ± 0.693

Na I · Codex-graded lines · 1D NLTE (Amarsi) · CRIRES+ H · Codex Grade

K

5.903 ± 0.137

Na I · Codex-graded lines · 1D NLTE (Amarsi) · CRIRES+ · Codex Grade

Line grades

Every product is measured on one of three grades of spectral lines and the grades are never mixed in one number.

Grade	What it means	This element
Reference Grade	lines from a published solar line set (Asplund et al. 2021 and similar), measured with the oscillator strengths the authors used	20 products -- Na I · Asplund et al. 2021 lines
Codex Grade	lines chosen by the Codex whose oscillator strength carries a published uncertainty (laboratory measurement, NIST accuracy class A-C, or the paper's own stated error), between 5% and 60% deep	44 products -- Na I · Codex-graded lines
Deep Grade	the same oscillator-strength rule on lines deeper than 60% -- stronger lines, more sensitive to damping and the model atmosphere	23 products -- Na I · Deep-graded lines

Error-bar Forest Plot

near-UV — Kitt Peak (Kurucz 2005)
A(Na) dex; axis 6.14–6.89

Na I · Deep-graded lines · 1D LTE Deep Grade · 2 lines		6.689 ±0.153
Na I · Deep-graded lines · 1D NLTE (Amarsi) Deep Grade · 2 lines		6.574 ±0.159
Na I · Deep-graded lines · 1D NLTE (Gerber) Deep Grade · 2 lines		6.671 ±0.141
Na I · Deep-graded lines · 1D LTE (Gerber) Deep Grade · 2 lines		6.713 ±0.145

near-UV — Kitt Peak (1984, molecfit)
A(Na) dex; axis 6.14–6.89

Na I · Deep-graded lines · 1D LTE Deep Grade · 2 lines		6.465 ±0.173
Na I · Deep-graded lines · 1D NLTE (Amarsi) Deep Grade · 2 lines		6.350 ±0.179
Na I · Deep-graded lines · 1D NLTE (Gerber) Deep Grade · 2 lines		6.437 ±0.162
Na I · Deep-graded lines · 1D LTE (Gerber) Deep Grade · 2 lines		6.489 ±0.162

near-UV axis: 6.14 · 6.33 · 6.51 · 6.70 · 6.89 A(Na) dex

VIS — HARPS
A(Na) dex; axis 5.99–6.40

Na I · Asplund et al. 2021 lines · 1D LTE Reference Grade · 4 lines		6.278 ±0.052
Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) Reference Grade · 4 lines		6.264 ±0.053
Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) Reference Grade · 4 lines		6.226 ±0.054
Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) Reference Grade · 4 lines		6.263 ±0.054
Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) Reference Grade · 4 lines		6.282 ±0.052
Na I · Deep-graded lines · 1D LTE Deep Grade · 2 lines		6.228 ±0.039
Na I · Deep-graded lines · 3D NLTE (Amarsi) Deep Grade · 2 lines		6.239 ±0.074
Na I · Deep-graded lines · 1D NLTE (Amarsi) Deep Grade · 1 line		6.102 ±0.075
Na I · Deep-graded lines · 1D NLTE (Gerber) Deep Grade · 2 lines		6.218 ±0.039
Na I · Deep-graded lines · 1D LTE (Gerber) Deep Grade · 2 lines		6.243 ±0.040
Na I · Codex-graded lines · 1D LTE Codex Grade · 7 lines		6.283 ±0.081
Na I · Codex-graded lines · 3D NLTE (Amarsi) Codex Grade · 6 lines		6.264 ±0.090
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 7 lines		6.226 ±0.074
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 7 lines		6.265 ±0.071
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 7 lines		6.287 ±0.081

VIS — Kitt Peak (Kurucz 2005)
A(Na) dex; axis 5.99–6.40

Na I · Asplund et al. 2021 lines · 1D LTE Reference Grade · 4 lines		6.300 ±0.047
Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) Reference Grade · 4 lines		6.287 ±0.047
Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) Reference Grade · 4 lines		6.248 ±0.048

VIS — Kitt Peak (Kurucz 2005)
A(Na) dex; axis 5.99–6.40

Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) Reference Grade · 4 lines		6.284 ±0.048
Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) Reference Grade · 4 lines		6.305 ±0.047
Na I · Deep-graded lines · 1D LTE Deep Grade · 2 lines		6.250 ±0.038
Na I · Deep-graded lines · 3D NLTE (Amarsi) Deep Grade · 2 lines		6.260 ±0.073
Na I · Deep-graded lines · 1D NLTE (Amarsi) Deep Grade · 1 line		6.104 ±0.075
Na I · Deep-graded lines · 1D NLTE (Gerber) Deep Grade · 2 lines		6.236 ±0.040
Na I · Deep-graded lines · 1D LTE (Gerber) Deep Grade · 2 lines		6.263 ±0.037
Na I · Codex-graded lines · 1D LTE Codex Grade · 7 lines		6.290 ±0.045
Na I · Codex-graded lines · 3D NLTE (Amarsi) Codex Grade · 6 lines		6.287 ±0.050
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 7 lines		6.243 ±0.046
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 7 lines		6.275 ±0.045
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 7 lines		6.295 ±0.045

VIS — Kitt Peak (1984, molecfit)
A(Na) dex; axis 5.99–6.40

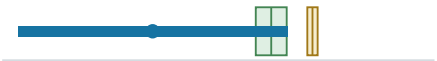
Na I · Asplund et al. 2021 lines · 1D LTE Reference Grade · 4 lines		6.304 ±0.047
Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) Reference Grade · 4 lines		6.291 ±0.048
Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) Reference Grade · 4 lines		6.252 ±0.048
Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) Reference Grade · 4 lines		6.278 ±0.049
Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) Reference Grade · 4 lines		6.309 ±0.048
Na I · Deep-graded lines · 1D LTE Deep Grade · 2 lines		6.221 ±0.039

VIS — Kitt Peak (1984, molecfit)
A(Na) dex; axis 5.99–6.40

Na I · Deep-graded lines · 3D NLTE (Amarsi) Deep Grade · 2 lines		6.232 ±0.074
Na I · Deep-graded lines · 1D NLTE (Amarsi) Deep Grade · 1 line		6.095 ±0.074
Na I · Deep-graded lines · 1D NLTE (Gerber) Deep Grade · 2 lines		6.210 ±0.037
Na I · Deep-graded lines · 1D LTE (Gerber) Deep Grade · 2 lines		6.235 ±0.040
Na I · Codex-graded lines · 1D LTE Codex Grade · 7 lines		6.294 ±0.045
Na I · Codex-graded lines · 3D NLTE (Amarsi) Codex Grade · 6 lines		6.291 ±0.049
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 7 lines		6.247 ±0.046
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 7 lines		6.266 ±0.045
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 7 lines		6.298 ±0.045

VIS axis: 5.99 · 6.09 · 6.19 · 6.30 · 6.40 A(Na) dex

red-optical — IAG FTS
A(Na) dex; axis 5.70–6.54

Na I · Codex-graded lines · 1D LTE Codex Grade · 4 lines		6.327 ±0.165
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 2 lines		5.990 ±0.262
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 4 lines		6.332 ±0.175

red-optical — Kitt Peak (Kurucz 2005)
A(Na) dex; axis 5.70–6.54

Na I · Codex-graded lines · 1D LTE Codex Grade · 4 lines		6.322 ±0.058
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 2 lines		6.231 ±0.043
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 4 lines		6.271 ±0.081
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 4 lines		6.327 ±0.058

red-optical — Kitt Peak (1984, molecfit)
A(Na) dex; axis 5.70–6.54

Na I · Codex-graded lines · 1D LTE Codex Grade · 5 lines		6.364 ±0.066
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 3 lines		6.262 ±0.076
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 5 lines		6.338 ±0.091
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 5 lines		6.370 ±0.066

red-optical axis: 5.70 · 5.91 · 6.12 · 6.33 · 6.54 A(Na) dex

NIR — CRIRES+ J
A(Na) dex; axis 5.79–6.54

Na I · Codex-graded lines · 1D LTE Codex Grade · 2 lines		6.213 ±0.294
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 1 line		5.901 ±0.084
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 2 lines		6.196 ±0.281
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 2 lines		6.215 ±0.294

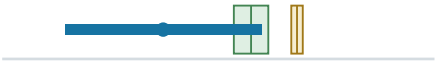
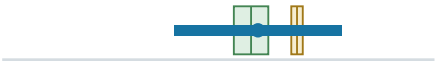
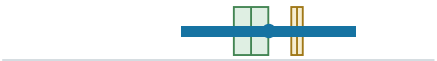
NIR — CRIRES+ Y (full arm)
A(Na) dex; axis 5.79–6.54

Na I · Codex-graded lines · 1D LTE Codex Grade · 1 line		6.123 ±0.047
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 1 line		6.105 ±0.047
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 1 line		6.108 ±0.054
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 1 line		6.122 ±0.047

NIR — Kitt Peak (1984, molecfit)
A(Na) dex; axis 5.79–6.54

Na I · Asplund et al. 2021 lines · 1D LTE Reference Grade · 1 line		6.301 ±0.040
Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) Reference Grade · 1 line		6.328 ±0.040
Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) Reference Grade · 1 line		6.295 ±0.040

NIR — Kitt Peak (1984, molecfit)
A(Na) dex; axis 5.79–6.54

Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) Reference Grade · 1 line		6.266 ±0.181
Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) Reference Grade · 1 line		6.303 ±0.040
Na I · Codex-graded lines · 1D LTE Codex Grade · 3 lines		6.252 ±0.151
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 2 lines		6.067 ±0.171
Na I · Codex-graded lines · 1D NLTE (Gerber) Codex Grade · 3 lines		6.232 ±0.146
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 3 lines		6.251 ±0.152

NIR axis: 5.79 · 5.97 · 6.16 · 6.35 · 6.54 A(Na) dex

H — CRIRES+ H
A(Na) dex; axis 5.06–6.55

Na I · Codex-graded lines · 1D LTE Codex Grade · 3 lines		5.796 ±0.693
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 3 lines		5.779 ±0.693
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 3 lines		5.803 ±0.714

H axis: 5.06 · 5.43 · 5.80 · 6.17 · 6.55 A(Na) dex

K — CRIRES+
A(Na) dex; axis 5.72–6.34

Na I · Codex-graded lines · 1D LTE Codex Grade · 7 lines		5.898 ±0.148
Na I · Codex-graded lines · 1D NLTE (Amarsi) Codex Grade · 7 lines		5.903 ±0.137
Na I · Codex-graded lines · 1D LTE (Gerber) Codex Grade · 7 lines		5.899 ±0.147

K axis: 5.72 · 5.88 · 6.03 · 6.19 · 6.34 A(Na) dex

How to read this forest. Each row is one independent product, preserving its band, holding, engine, indicator and line set. Engines and indicator families are never averaged. Each bar is the uncertainty as Asplund et al. 2021 quote it: line-to-line scatter, the 3D-model term and the NLTE term (at least 0.03 dex). For a molecule the NLTE term is replaced by its dependence on the other element, and the 3D term comes from the 3D-to-1D difference Amarsi et al. 2021 publish for the same band. Atomic-data and observational terms are not in the bar, as in Asplund; they stay in the full error budget attached to the row. Grades describe the supplied line-pool provenance, not engine quality; evaluated theoretical CNO oscillator strengths are not relabelled as laboratory evidence. Quarantined, failed and unconstrained fits have no abundance mark. Experimental products remain explicitly not adopted. Literature references provide context, never tuning

targets. Yellow rows are Deep Grade: strong lines that saturate, kept but less certain than the other grades.

How this was measured

Every sodium value on this page comes from fitting synthetic spectra to the observed solar spectrum, line by line or band by band, with the sodium abundance as the free parameter. The synthesis includes the atomic lines and the molecular opacity in every window, so blended absorption is modelled rather than attributed to the line being measured. The continuum is placed locally around every line by comparing the observation with the synthesis on its own highest pixels, and ground-based spectra are telluric-corrected across their full range.

Each indicator is measured independently on each solar spectrum and reported separately; nothing is averaged across indicators or instruments. Where a 3D or NLTE correction is published for the lines, it is applied as its own product (1D-LTE, 1D-NLTE and 3D-NLTE are separate rows). Every value carries a full uncertainty budget: fit, line strengths, microturbulence, continuum, fit window, model atmosphere, telluric residual, and the spread between spectra, each measured by refitting with that one input changed. The headline at the top is the Asplund-grade product: a published line set, the most complete treatment, then the most lines.

Band	near-UV
What was measured	Na I · Deep-graded lines
Solar spectra	Kitt Peak (1984, molecfit), Kitt Peak (Kurucz 2005)
Treatments	1D-LTE, 1D-NLTE
Lines	2
Result A(Na)	6.350–6.671 (1D-NLTE)
Largest uncertainty terms (dex)	fit / line-to-line scatter 0.14, microturbulence 0.08

Band	VIS
What was measured	Na I · Deep-graded lines
Solar spectra	HARPS, Kitt Peak (1984, molecfit), Kitt Peak (Kurucz 2005)
Treatments	1D-LTE, 1D-NLTE, 3D-NLTE
Lines	1–2
Result A(Na)	6.232–6.260 (3D-NLTE)
Largest uncertainty terms (dex)	fit window 0.32, NLTE / 3D correction 0.07

Band	VIS
What was measured	Na I · Codex-graded lines
Solar spectra	HARPS, Kitt Peak (1984, molecfit), Kitt Peak (Kurucz 2005)
Treatments	1D-LTE, 1D-NLTE, 3D-NLTE
Lines	6–7
Result A(Na)	6.264–6.291 (3D-NLTE)
Largest uncertainty terms (dex)	fit / line-to-line scatter 0.03, NLTE / 3D correction 0.03

Band	VIS
What was measured	Na I · Asplund et al. 2021 lines
Solar spectra	HARPS, Kitt Peak (1984, molecfit), Kitt Peak (Kurucz 2005)
Treatments	1D-LTE, 1D-NLTE, 3D-NLTE

Band	VIS
What was measured	Na I · Asplund et al. 2021 lines
Lines	4
Result A(Na)	6.264–6.291 (3D-NLTE)
Largest uncertainty terms (dex)	continuum placement 0.04, NLTE / 3D correction 0.03

Band	red-optical
What was measured	Na I · Codex-graded lines
Solar spectra	IAG FTS, Kitt Peak (1984, molecfit), Kitt Peak (Kurucz 2005)
Treatments	1D-LTE, 1D-NLTE
Lines	2–5
Result A(Na)	5.990–6.338 (1D-NLTE)
Largest uncertainty terms (dex)	continuum placement 0.22, fit window 0.20

Band	NIR
What was measured	Na I · Codex-graded lines
Solar spectra	CRIRES+ J, CRIRES+ Y (full arm), Kitt Peak (1984, molecfit)
Treatments	1D-LTE, 1D-NLTE
Lines	1–3
Result A(Na)	5.901–6.232 (1D-NLTE)
Largest uncertainty terms (dex)	fit / line-to-line scatter 0.14, fit window 0.07

Band	NIR
What was measured	Na I · Asplund et al. 2021 lines
Solar spectra	Kitt Peak (1984, molecfit)
Treatments	1D-LTE, 1D-NLTE, 3D-NLTE
Lines	1
Result A(Na)	6.328 (3D-NLTE)
Largest uncertainty terms (dex)	NLTE / 3D correction 0.03, fit / line-to-line scatter 0.02

Band	H
What was measured	Na I · Codex-graded lines
Solar spectra	CRIRES+ H
Treatments	1D-LTE, 1D-NLTE
Lines	3
Result A(Na)	5.779 (1D-NLTE)
Largest uncertainty terms (dex)	fit / line-to-line scatter 0.69, telluric residual 0.54

Band	K
What was measured	Na I · Codex-graded lines
Solar spectra	CRIRES+
Treatments	1D-LTE, 1D-NLTE
Lines	7
Result A(Na)	5.903 (1D-NLTE)
Largest uncertainty terms (dex)	fit / line-to-line scatter 0.13, telluric residual 0.12

Excluded lines

These lines are left out of the Sun's measurement. They stay in the line lists: a cooler or more evolved star may measure them well. Blended lines are not excluded -- the spectrum synthesis models the blend. 1 lines.

Species	Wavelength (Å, air)	Why it is excluded
Na I	4242.081	atomic_blend

Solar sodium context

Sodium is traced by neutral Na I lines from the near-ultraviolet to the K band. The reference lines are the five Asplund et al. 2021 used (4751, 5148, 6154, 6160 and 10746 Å), with the oscillator strengths they adopted. Na I departs from LTE, so each spectrum also carries non-LTE products; each set, spectrum and treatment remains a separate product.

Published line sets · gf uncertainty model · Methodology

Download the evidence

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Source feed — includes quarantined fit outputs, not adopted abundances

Complete product visibility audit

Shared website/PDF report

Reproducibility manifest

Complete references and product-to-source bindings

Reproducibility

Generated from the pinned science snapshot. Source commit
e76c06c6173928306b433a805509e63a1a206c71
Feed Na.json v1.158 · updated 2026-11-04T01:32:12Z
Generated 2026-11-05T21:50:45-07:00 (source commit timestamp)
Feed SHA-256 f402244800e12a2ce57c1ea71a7eb122e2d3eb378beb0172c55e56483438bfb8
Generator scripts/generate_cno_publication.py v1.0.0

Pinned scientific source

References / Data & Model Sources

Sources are separated by their role. Registered grid lineage and quarantined diagnostics do not imply an adopted abundance or an applied correction.

See the source notes for the distinction between reference lineage and the treatment actually recorded in each feed entry.

Science and provenance source notes

Solar abundance and indicator analyses. Solar Na comparison literature; not an adopted Codex abundance. Sources: [1], [2].

Atomic data and gf authorities. Na I oscillator strengths of this pool, as the product's own uncertainty budget records them (with their lineage). Sources: [3].

Model and grid sources. Feed treatment: 1D-LTE synthesis (Turbospectrum); no NLTE/3D correction claimed. Sources: [4].

Model and grid sources. Feed treatment: 1D NLTE, per-line correction from the Amarsi 2020 GALAH departure grid via PySME (data/nlte_grids/Na_Amarsi2020_PySME.csv). Sources: [5].

Model and grid sources. Feed treatment: synth-1D-LTE-gerber; Turbospectrum on the registered Gerber deck. The product retains its own atmosphere and ion identity. Sources: [4].

Model and grid sources. Feed treatment: ENGINE-B-NLTE; Turbospectrum on the registered Gerber deck. The product retains its own atmosphere and ion identity. Sources: [4].

Solar abundance and indicator analyses. Published line set NA_AGSS21 (the line selection). Sources: [1].

Model and grid sources. Cited solar abundance differences from the published model columns, applied additively to our LTE fits; not a new in-transfer 3D calculation. Baseline atmosphere: A_marcs_lte, A_1d_lte Sources: [1], [6].

Model and grid sources. Cited solar abundance differences from the published model columns, applied additively to our LTE fits; not a new in-transfer 3D calculation. Baseline atmosphere: A_marcs_lte Sources: [1].

Product-to-source index

H · CRIRES+ H · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-fb210d1eee02

H · CRIRES+ H · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-a80b76db5d6a

H · CRIRES+ H · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-c047829fd0f2

K · CRIRES+ · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-0552befecb14

K · CRIRES+ · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-4f1dee816393

K · CRIRES+ · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-caab8cbc99e0

NIR · CRIRES+ J · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-1229a0a156f8

NIR · CRIRES+ J · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-f1c4ef0ec48e

NIR · CRIRES+ J · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-65e9578f5f35

NIR · CRIRES+ J · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-448c77475a54

NIR · CRIRES+ Y (full arm) · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-85aee27b99bb

NIR · CRIRES+ Y (full arm) · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-118aa2ad0c1e

NIR · CRIRES+ Y (full arm) · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-81eca203f5c6

NIR · CRIRES+ Y (full arm) · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-6637f12ec02e

NIR · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D LTE · [1], [2], [3], [4] Na-products-18e5094f3c43

NIR · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-c474eb26f3ae

NIR · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-bb8baa1178c8

NIR · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-bf2a2938353f

NIR · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-dc40cd57490f

NIR · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-bdcd99128c04

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NIR · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-c0ce41acfee8

NIR · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-186caf770fd6

VIS · HARPS · Na I · Asplund et al. 2021 lines · 1D LTE · [1], [2], [3], [4] Na-products-65aef47bc520

VIS · HARPS · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-0bac2ebdc4ba

VIS · HARPS · Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-d70898a6d4f2

VIS · HARPS · Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-9439cb57fb7e

VIS · HARPS · Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-5919b5d71e97

VIS · HARPS · Na I · Deep-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-ab243f5f7fb7

VIS · HARPS · Na I · Deep-graded lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-cd4f141ff187

VIS · HARPS · Na I · Deep-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-77cd03c01180

VIS · HARPS · Na I · Deep-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-252fafda80c1

VIS · HARPS · Na I · Deep-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-f7b85afbd89a

VIS · HARPS · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-4c88219f1ea2

VIS · HARPS · Na I · Codex-graded lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-034d202da814

VIS · HARPS · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-1a483ec17b8d

VIS · HARPS · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-a3583bba6864

VIS · HARPS · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-abce6000c004

VIS · Kitt Peak (Kurucz 2005) · Na I · Asplund et al. 2021 lines · 1D LTE · [1], [2], [3], [4] Na-products-b06ed066892d

VIS · Kitt Peak (Kurucz 2005) · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-620b8337a6f5

VIS · Kitt Peak (Kurucz 2005) · Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-69a7aa7bb39f

VIS · Kitt Peak (Kurucz 2005) · Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-b90c5f56677b

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VIS · Kitt Peak (Kurucz 2005) · Na I · Deep-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-3549f0317ecb

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VIS · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-be7b30000a66

VIS · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-23bfd23782d9

VIS · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-17cc53288fb1

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VIS · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-f0d7d3616c1c

VIS · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D NLTE (Amarsi) · [1], [2], [3] Na-products-fd002196b613

VIS · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-0276917cf012

VIS · Kitt Peak (1984, molecfit) · Na I · Asplund et al. 2021 lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-6d05db230769

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VIS · Kitt Peak (1984, molecfit) · Na I · Deep-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-a5cee5792af3

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VIS · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 3D NLTE (Amarsi) · [1], [2], [3], [6] Na-products-f8e30b062164

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near-UV · Kitt Peak (Kurucz 2005) · Na I · Deep-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-4d5f9acb10d8

near-UV · Kitt Peak (Kurucz 2005) · Na I · Deep-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-0c24e0ee234b

near-UV · Kitt Peak (Kurucz 2005) · Na I · Deep-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-9e68e7906843

near-UV · Kitt Peak (Kurucz 2005) · Na I · Deep-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-32c8f839e09e

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near-UV · Kitt Peak (1984, molecfit) · Na I · Deep-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-9ac31d7523ad

near-UV · Kitt Peak (1984, molecfit) · Na I · Deep-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-17a68269f94a

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red-optical · IAG FTS · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-29aa33878906

red-optical · IAG FTS · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-81cf47912679

red-optical · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-256c3fc7e0b8

red-optical · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-7699e2dbb81f

red-optical · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-04067e028764

red-optical · Kitt Peak (Kurucz 2005) · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4] Na-products-0e50a7927295

red-optical · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D LTE · [1], [2], [3], [4] Na-products-2755c55a0874

red-optical · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D NLTE (Amarsi) · [1], [2], [3], [5] Na-products-352e51858fa7

red-optical · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D NLTE (Gerber) · [1], [2], [3], [4] Na-products-aa11fabbd085

red-optical · Kitt Peak (1984, molecfit) · Na I · Codex-graded lines · 1D LTE (Gerber) · [1], [2], [3], [4]
Na-products-af83ab9b05b0

Complete applicable bibliography

Solar abundance and indicator analyses

[1] — Asplund, M.; Amarsi, A. M.; Grevesse, N. (2021). The chemical make-up of the Sun: A 2020 vision. A&A 653, A141 DOI: 10.1051/0004-6361/202140445. source record

[2] — Lodders, K.; Bergemann, M.; Palme, H. (2025). Solar System Elemental Abundances from the Solar Photosphere and CI-Chondrites. Space Science Reviews 221 DOI: 10.1007/s11214-025-01146-w. source record

Atomic data and gf authorities

[3] — Kramida, A.; Ralchenko, Yu.; Reader, J.; NIST ASD Team (2024). NIST Atomic Spectra Database (version 5.11/5.12). National Institute of Standards and Technology, Gaithersburg, MD DOI: 10.18434/T4W30F. source record

Model and grid sources

[4] — Gerber, J. M.; Magg, E.; Plez, B.; Bergemann, M.; Heiter, U.; Olander, T.; Hoppe, R. (2023). Non-LTE radiative transfer with Turbospectrum. A&A 669, A43 DOI: 10.1051/0004-6361/202243673. source record

[5] — Amarsi, A. M.; Lind, K.; Osorio, Y.; Nordlander, T.; Bergemann, M.; et al. (2020). The GALAH Survey: non-LTE departure coefficients for large spectroscopic surveys. A&A 642, A62 DOI: 10.1051/0004-6361/202038650. source record

[6] — Canocchi, G.; Wang, E. X.; Amarsi, A. M.; Lind, K.; Racca, M. (2026). 3D NLTE Sodium abundances in late-type stars. arXiv 2603.22975 DOI: 10.5281/zenodo.19201830. source record