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Identification of δ Scuti, γ Doradus Stars, and Eclipsing Binaries with *TESS* (V)

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ABSTRACT

I analyzed Transiting Exoplanet Survey Satellite (*TESS*) data for 56,163 AF-type stars with effective temperatures between 6500 and 8100 K and *TESS* magnitudes of $11\overset{m}{.}202$–$12\overset{m}{.}45$ to search for δ Scuti and γ Doradus variables. This survey resulted in the identification of 9826 new variable stars, comprising 3575 δ Scuti stars, 3191 γ Doradus stars (including 705 hybrids), 1533 eclipsing binaries (175 of which host pulsating components), 1472 rotational variables, 32 RR Lyrae stars, and a few other types.

Keywords: Pulsating variable stars(1307) — δ Scuti variable stars(370) — γ Doradus variable stars(2101) — Eclipsing binary stars(444)

1. INTRODUCTION

This work continues a multi-survey project aimed at identifying new pulsating variables and eclipsing binaries among stars of spectral types A and F ('AF' stars) using photometry from the Transiting Exoplanet Survey Satellite (*TESS*, Ricker et al. 2015). Survey I searched for new δ Sct stars within 1° of the known δ Sct star V1821 Cygni in NGC 6871 (Zhou 2023a, 2025a) ; Survey II examined a two-degree region around the SX Phe star BL Cam (Zhou 2024); and Survey III investigated an all-sky sample of ∼709,200 AF stars with effective temperatures between 6500 and 8100 K, spanning the overlap of the δ Sct and γ Dor instability strips (project "AF50w").

Preliminary results from the first phase of Survey III, based on analyses of 62,912 AF stars, were promptly published in Research Notes of the American Astronomical Society (RNAAS) Volume 9, Number 1 (Zhou 2025b). Results from the second phase of Survey III, based on an additional 95,469 AF stars, were subsequently published in RNAAS

Table 1. Multiple surveys for identifying new AF-type pulsating variables and eclipsing binaries.

Zenodo Dataset	Survey: Project	Release: Phase	Release Date
Version 5.0	III: all-sky 709,200 AF stars	Part V: R3	Dec 29, 2025
Version 4.5	III: all-sky 709,200 AF stars	Part IV: R2	Oct 19, 2025
Version 4.0	III: all-sky 709,200 AF stars	Part IV: R2	Sep 10, 2025
Version 3.0	III: all-sky 709,200 AF stars	Part III: R1	Jan 20, 2025
Version 2.0	II: 2° around BL Cam	Part II: -	Sep 05, 2024
Version 1.0	I: 1° around NGC 6302	Part I: -	Aug 29, 2024
	1° around V1821 Cyg		
Notes: Use the latest version and ignore the earlier versions			

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Volume 9, Number 11 (Zhou 2025c). The present note reports preliminary results from the third phase of Survey III, based on a further 56,163 AF stars. Table 1 outlines the surveys.

The purpose of promptly releasing these newly classified variable stars is to promote community awareness and follow-up observations, while ensuring that known variables are properly recognized and thereby minimizing redundant searches and duplicate discoveries. Ongoing analyses of the newly identified eclipsing and pulsating binaries will be presented elsewhere.

2. SAMPLE AND DATA

Targets were selected from the *TESS* Input Catalog (TIC v8.2, Paegert et al. 2021) using three criteria: (1) effective temperatures between 8100 and 6500 K (corresponding to main-sequence A5–F6, spanning the δ Sct–γ Dor instability strips); (2) *TESS* magnitudes of $11^{\rm m}.20$–$12^{\rm m}.45$, V magnitudes of $10^{\rm m}.26$–$13^{\rm m}.275$, and stellar masses between 1.15 and 3.20 $M_{\odot}$; and (3) exclusion of sources listed in Gootkin et al. 2024. From 709,226 AF-type stars, 56,163 objects with available *TESS* data were analyzed in this third phase. Light curves were obtained from `MAST` (Barbara A. Mikulski Archive for Space Telescopes[1]), with stellar parameters and the Hertzsprung-Russell (H-R) diagram positions were drawn from Simbad, TIC v8.2, and *Gaia* (Gaia Collaboration et al. 2016, 2018, 2023).

3. METHODOLOGY AND IDENTIFICATION

Variability types were classified based on light-curve morphology and periodogram analysis, with astrophysical parameters used to determine stellar positions on the H-R diagram. The methodology follows that described in Zhou (2023a,b, 2025a,b). In addition, recent catalogs of *TESS* eclipsing binaries from full-frame images covering Sectors 1–82 (Kostov et al. 2025), as well as *TESS* AF p-mode and g-mode pulsator candidates and hybrid candidates reported by Kliapets et al. (2025) were incorporated for cross-checking, exclusion of known systems, and validation of new detections.

4. RESULTS

TESS light curves of 56,163 stars across the entire sky were examined, leading to the identification of 9,826 new variable stars (about 17.5% of the sample). These include 3575 δ Sct stars and 3191 γ Dor stars (including 705 hybrids), 1533 eclipsing binaries (including 175 cases that may involve a pulsating component or blending), 1472 rotating variables (including 268 ellipsoidal variables), and 32 RR Lyr stars. Among them, 517 stars were previously classified as 'PulsV' in Simbad or as 'msosc' or 'short_ts' in Gaia, which are now validated and reclassified as δ Sct, γ Dor stars, EB or ROT.

Combined with the first and second phases, *TESS* light curves for ∼214,225 AF-type stars have now been analyzed in Survey III, yielding roughly 42,037 new variable detections (19.6% of the analyzed stars), including 16,196 δ Sct stars, 14,012 γ Dor stars, 5724 eclipsing binaries, 6246 rotating variables, and 79 RR Lyr stars (see Table 2). Comprehensive information for all newly identified variables from this survey is available on Zenodo (DOI: 10.5281/zenodo.18080527) for immediate community access. Further investigations of the newly identified eclipsing and pulsating binaries are in progress, and the results will be reported elsewhere. The newly identified δ Sct and γ Dor stars have been compiled into dedicated catalogs of δ Sct and γ Dor variables, available at DOI: 10.5281/zenodo.11392129.

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[1] https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html

Table 2. Newly classified variables from survey III (project "AF50w")

Types	Phase-1	Phase-2	Phase-3	Sum	Notes
AF stars	62,912	95,150	56163	214,225	AF stars analyzed
New variables	15542	16669	9826	42,037	Total new variables
δ Sct	5512	7109	3575	16,196	DSCT
γ Dor	5655	5258	3191	14,012	GDOR
Hybrid	1426	1485	705	3,616	subset: DSCT+GDOR or GDOR+DSCT
EB	1710	2481	1533	5,724	EA/EB/EW
EA+Pul	415	340	175	930	subset with pulsating components
ROT	2690	2085	1472	6,246	ROT
ELL	190	151	268	609	subset of ROT
RR Lyr	22	25	32	79	RRab/RRc
PulsV/msosc	536	672	517	1,725	reclassified
short_ts					

APPENDIX

A. THE FIGURES PRESENTED IN EARLIER VERSIONS

A.1 Figures 1 and 2 presented in Version 4.5 (Survey III "AF50w", Phase-2b, Data Release 2).

A.2 Figures 3 and 4 presented in Version 4.0 (Survey III "AF50w", Phase-2, Data Release 2).

A.3 Figures 3 and 4 presented in Version 3.0 (Survey III "AF50w", Phase-1, Data Release 1).

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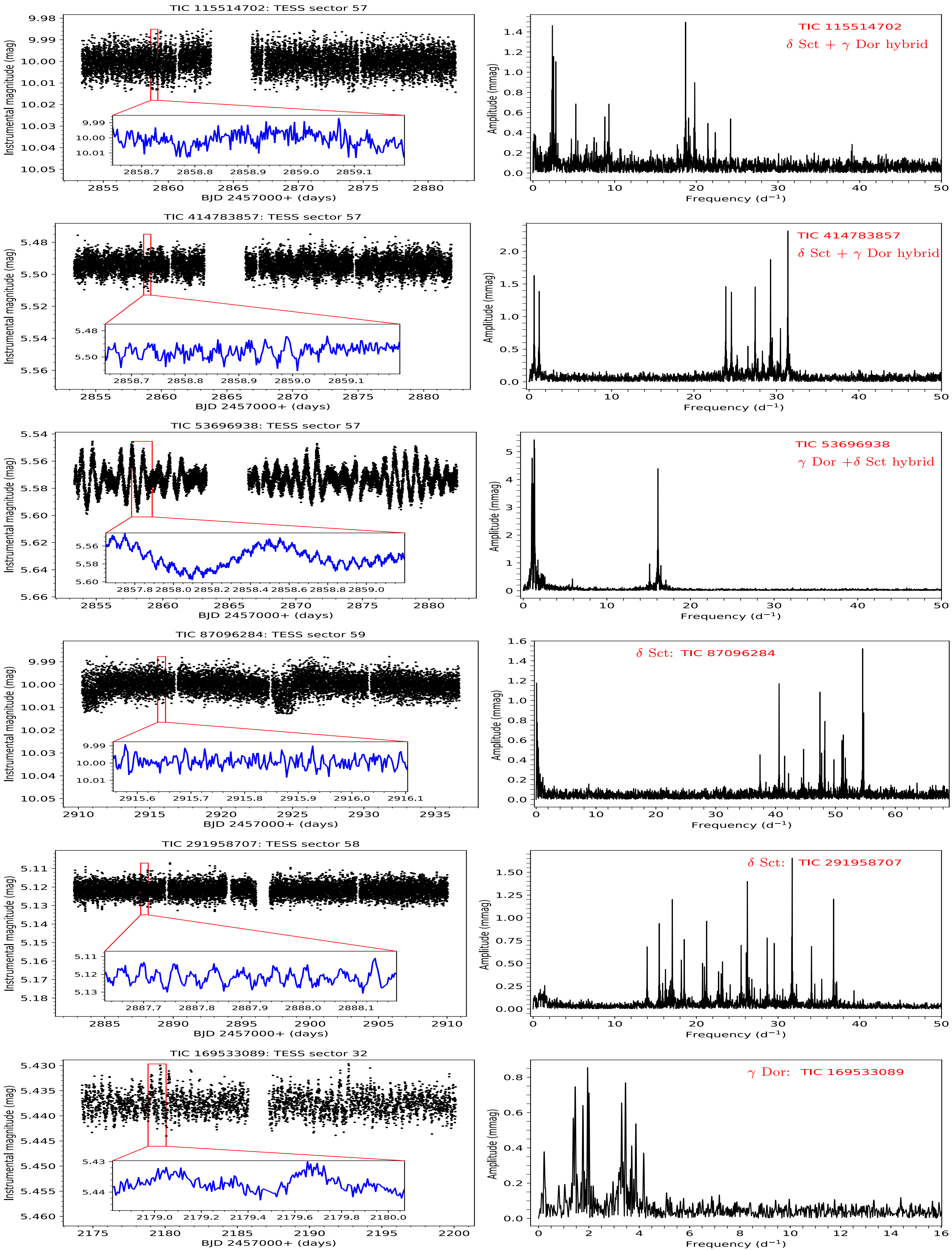

Figure 1. Examples of newly identified δ Sct, γ Dor stars and hybrid pulsators.

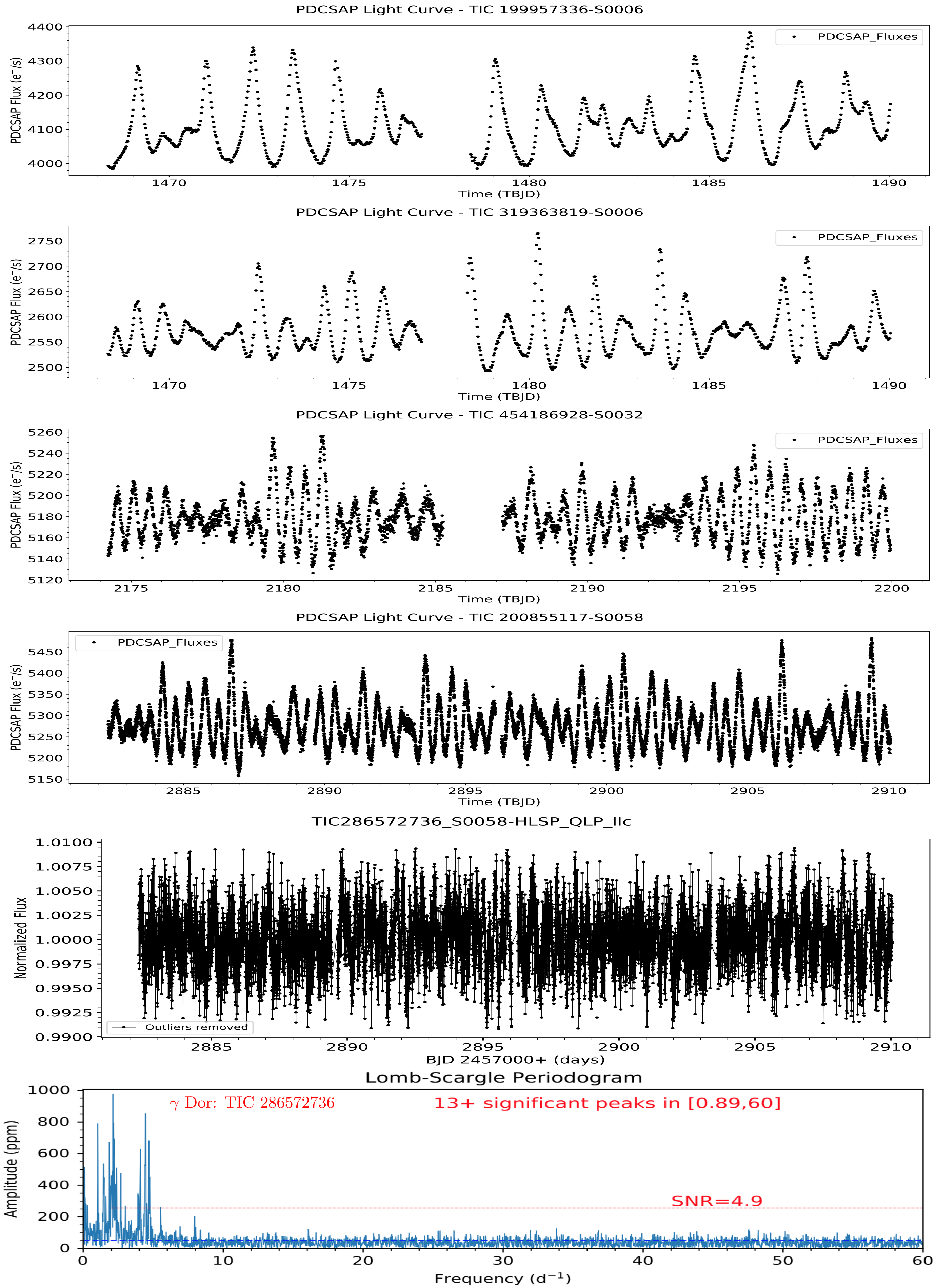

Figure 2. Examples of newly identified γ Dor stars with *TESS* data.

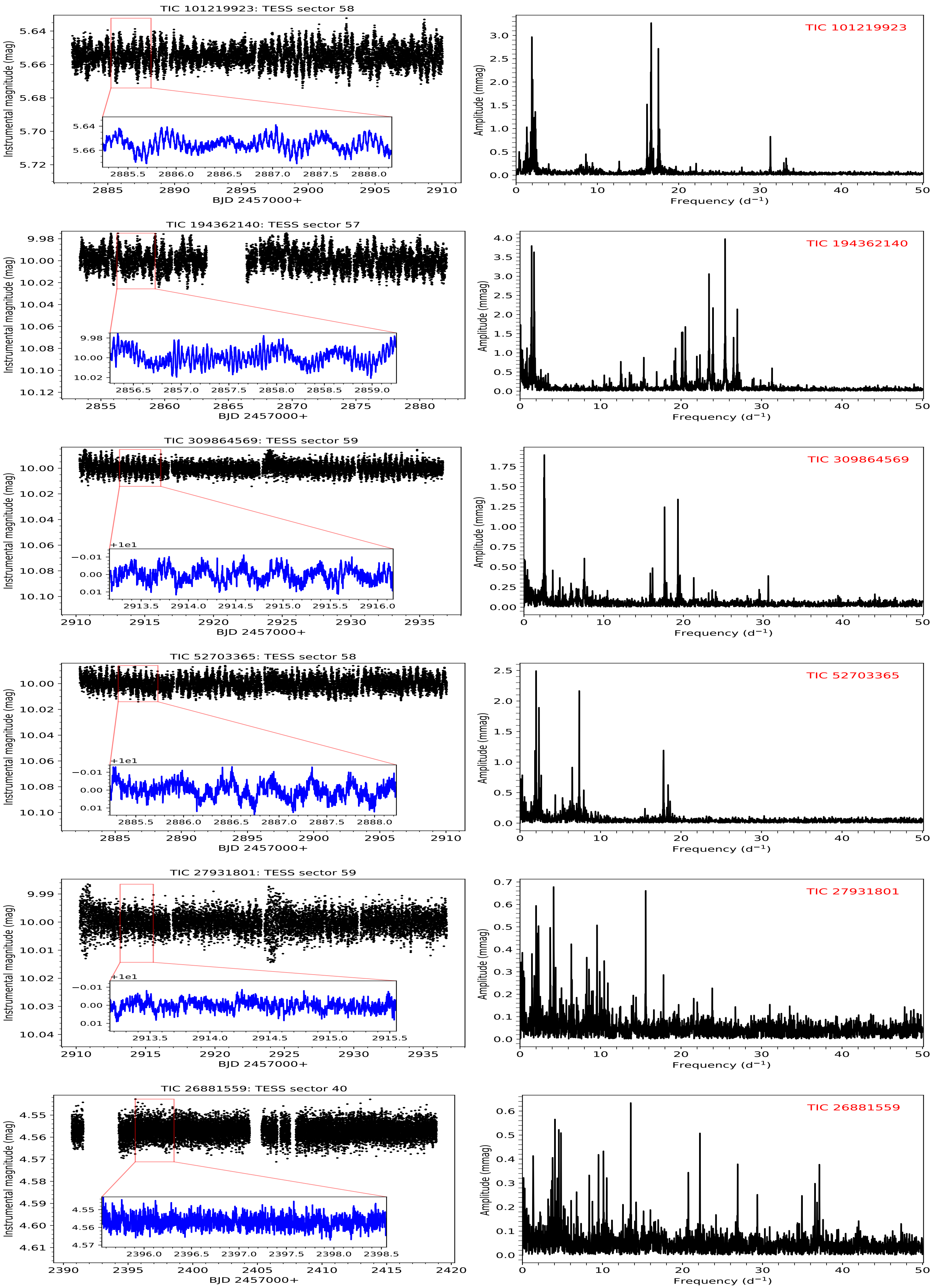

Figure 3. Examples of newly identified *TESS* hybrid δ Sct-γ Dor pulsators.

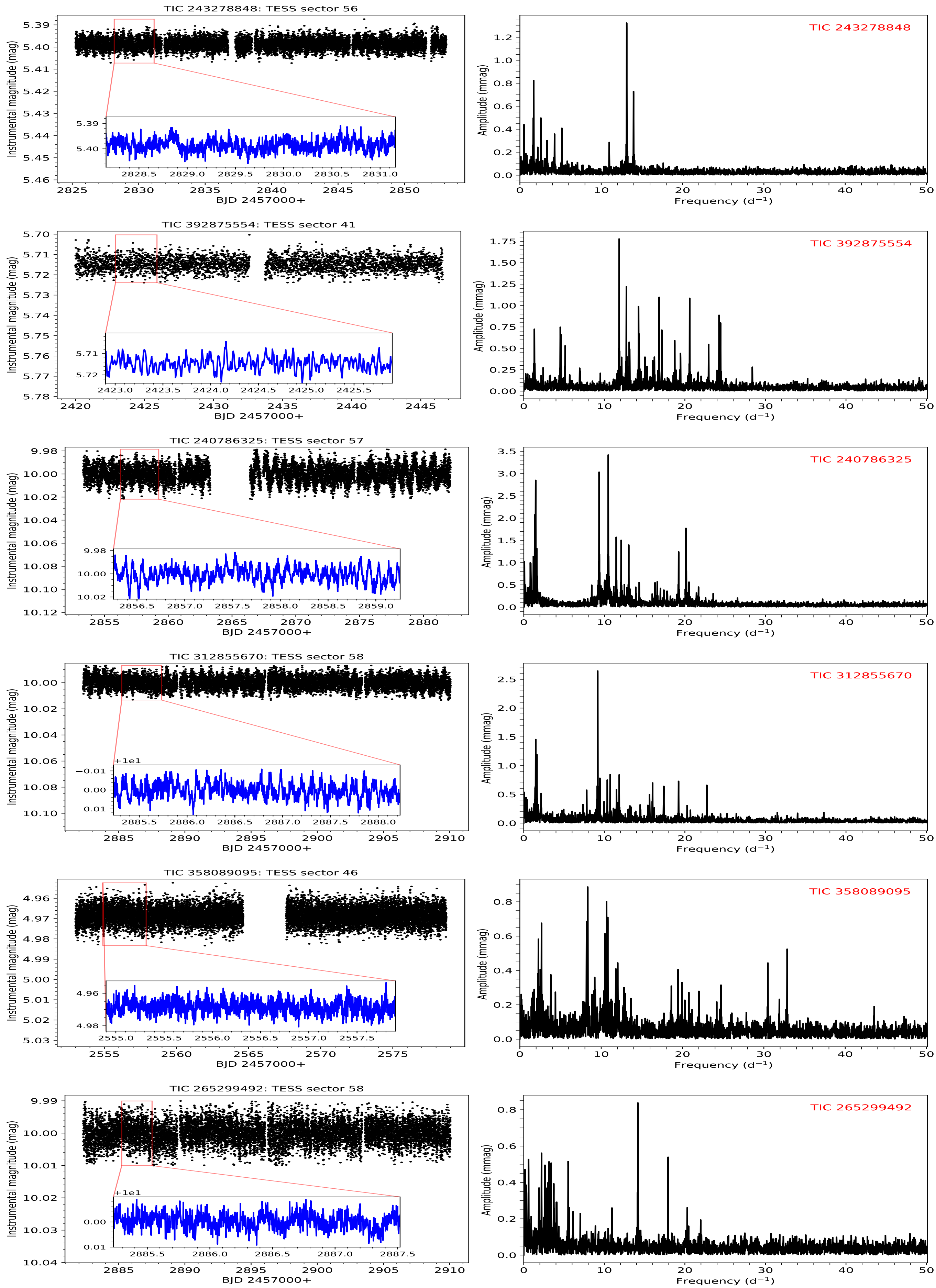

Figure 4. Examples of newly identified *TESS* hybrid δ Sct-γ Dor pulsators