Publication Year	2021
Acceptance in OA	2022-03-16T16:56:40Z
Title	The SPHERE infrared survey for exoplanets (SHINE). I. Sample definition and target characterization
Authors	DESIDERA, Silvano, Chauvin, G., Bonavita, M., MESSINA, Sergio, LeCoroller, H., SCHMIDT, TOBIAS MARIUS, GRATTON, Raffaele, Lazzoni, C., Meyer, M., Schlieder, J., Cheetham, A., Hagelberg, J., Bonnefoy, M., Feldt, M., Lagrange, A. -M., Langlois, M., Vigan, A., Tan, T. G., Hambsch, F. -J., Millward, M., ALCALA', JUAN MANUEL, BENATTI, SERENA, Brandner, W., Carson, J., COVINO, Elvira, Delorme, P., D'ORAZI, VALENTINA, Janson, M., RIGLIACO, ELISABETTA, Beuzit, J. -L., Biller, B., Boccaletti, A., Dominik, C., Cantalloube, F., Fontanive, C., Galicher, R., Henning, Th., Lagadec, E., LIGI, ROXANNE, Maire, A. -L., Menard, F., MESA, DINO, Müller, A., Samland, M., Schmid, H. M., Sissa, E., TURATTO, Massimo, Udry, S., Zurlo, A., Asensio-Torres, R., Kopytova, T., Rickman, E., Abe, L., Antichi, J., BARUFFOLO, Andrea, Baudoz, P., Baudrand, J., Blanchard, P., Bazzon, A., Buey, T., Carbillet, M., Carle, M., Charton, J., CASCONE, Enrico, CLAUDI, Riccardo, Costille, A., Deboulbé, A., DE CAPRIO, VINCENZO, Dohlen, K., FANTINEL, Daniela, Feautrier, P., Fusco, T., Gigan, P., GIRO, Enrico, Gisler, D., Gluck, L., Hubin, N., Hugot, E., Jaquet, M., Kasper, M., Madec, F., Magnard, Y., Martinez, P., Maurel, D., Le Mignant, D., Möller-Nilsson, O., Llored, M., Moulin, T., Origné, A., Pavlov, A., Perret, D., Petit, C., Pragt, J., Puget, P., Rabou, P., Ramos, J., Rigal, F., Rochat, S., Roelfsema, R., Rousset, G., Roux, A., SALASNICH, Bernardo, Sauvage, J. -F., Sevin, A., Soenke, C., Stadler, E., Suarez, M., Weber, L., Wildi, F.
Publisher's version (DOI)	10.1051/0004-6361/202038806
Handle	http://hdl.handle.net/20.500.12386/31639
Journal	ASTRONOMY & ASTROPHYSICS
Volume	651

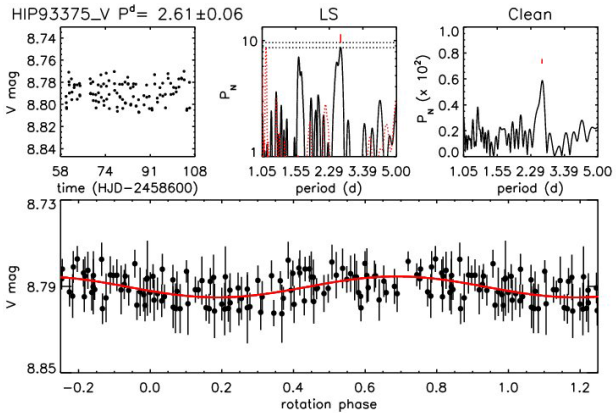

Fig. A.67. Photometric time sequence and periodogram for HIP 93375 (*V* band; ROAD data).

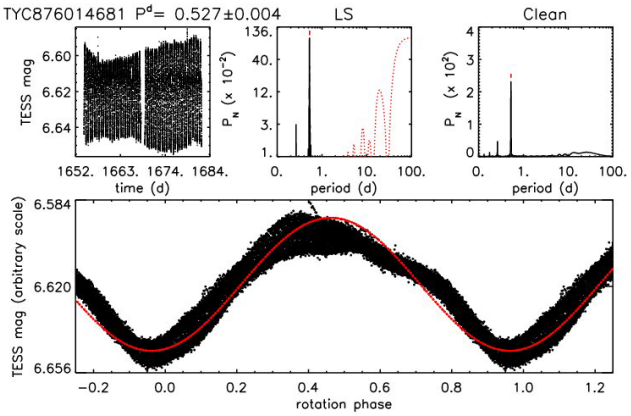

Fig. A.68. Photometric time sequence and periodogram for TYC 8760-1468-1.

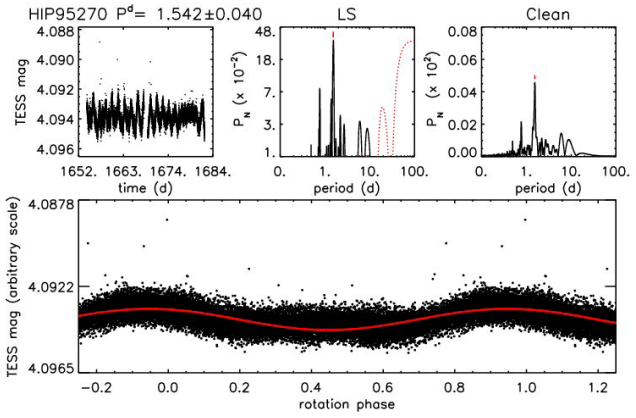

Fig. A.69. Photometric time sequence and periodogram for HIP 95270.

η **Tel = HIP 95261.** The star has a brown dwarf companion discovered by Lowrance et al. (2000) and confirmed by Guenther et al. (2001). It was not promoted as special object (P0) considering the already available characterization (e.g., Bonnefoy et al. 2014).

TYC 0486-4943-1. Member of AB Dor MG according to Torres et al. (2008) and Elliott et al. (2014). It has a low membership probability (19% for the adopted kinematic parameters) using BANYAN Σ. The lithium EW is very close to the median locus of AB Dor and Pleiades members, supporting a very similar age. The other age indicators are also compatible with this evaluation. Barenfeld et al. (2013) found some differences in the chemical composition with respect to AB Dor core members. We adopted an age very close to that of AB Dor MG with slightly increased error bars. From *Gaia* DR2 a wide companion (**2MASS J19330197+0345484**) with very similar parallax and proper motion is identified at 28″ (1968 au). The *Gaia* DR2 RV is also compatible with that of primary.

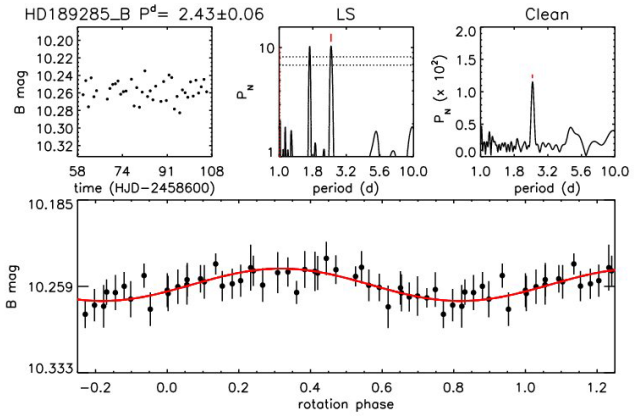

Fig. A.70. Photometric time sequence and periodogram for HD189285 (*B* band; ROAD data).

TYC 7443-1102-1. The *Herschel* IR source is actually identified with two separate sources at close separation from the star in ALMA observations (Tanner et al. 2020). This indicates they are likely background objects rather than associated with the star.

HD 189285. It is classified as a member of AB Dor in some studies (Torres et al. 2008), but BANYAN Σ returns a 0.0% membership probability. The discrepancy was already noticed in Desidera et al. (2015) using previous versions of the tool. On the other hand, all the age indicators (see Desidera et al. 2015, for details) are fully compatible with membership and Barenfeld et al. (2013) found that a chemical composition from several chemical elements is compatible with those of AB Dor core members. The kinematic discrepancy is unlikely to be due to unrecognized binarity as the RV from several sources (Desidera et al. 2015; Gaia Collaboration 2018; Elliott et al. 2014; Frasca et al. 2018) is compatible within the errors, and the SPHERE images do not give any indication of stellar companions. In summary, independently of any membership assignment, we adopted an age close to that of AB Dor MG with slightly increased error bars. We measured the rotation period from the photometric time series we collected at the ROAD observatory, which superseded the measurement presented in Desidera et al. (2015) and therein flagged as uncertain (Figs. A.70–A.71).

HIP 98470 = HD 189245. A reanalysis of the HIPPARCOS data allowed us to detect a rotation period $P = 0.8662 \pm 0.0003$ d, which, differently from that presented in Desidera et al. (2015), is consistent with the stellar radius and projected rotational velocity (Fig. A.72).

TYC 8404-0354-1 = CD-52 9381. K6Ve star proposed as an Argus member by Torres et al. (2008). Considered as likely older than Argus by Zuckerman (2019) on the basis of CMD. Lithium is also lower than expected for a 50 Myr star, and similar to the mean values of Pleaides and AB Dor stars of similar color. The very fast rotation period (0.83 days) is also compatible with this age estimate. Our isochrone analysis confirms the position close to the ZAMS. We adopted 120 (50–200) Myr.

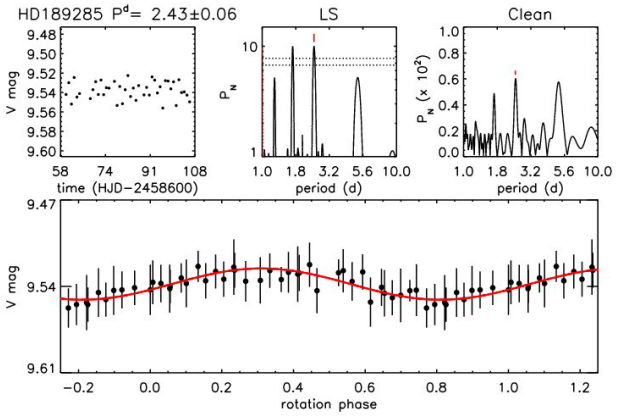

Fig. A.71. Photometric time sequence and periodogram for HD189285 (*V* band; ROAD data).

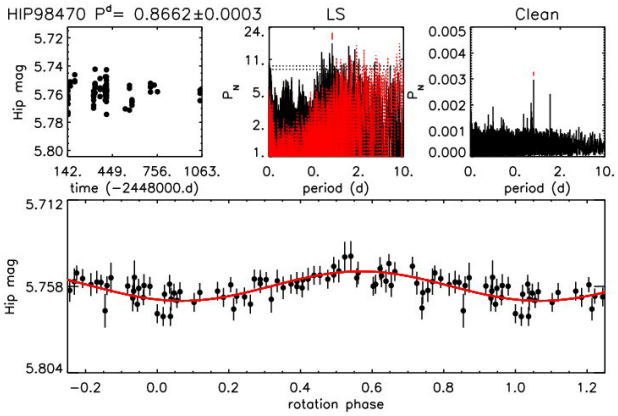

Fig. A.72. Photometric time sequence and periodogram for HIP 98470.

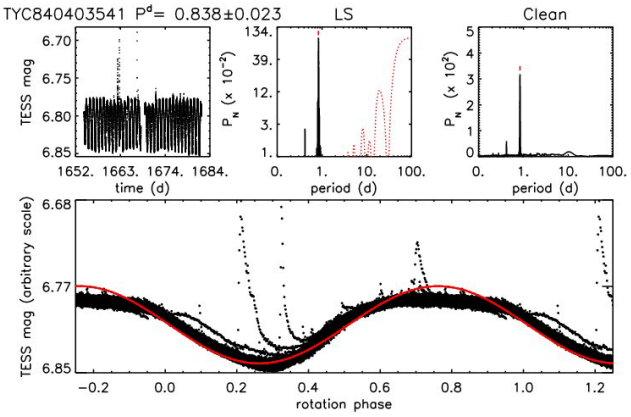

Fig. A.73. Photometric time sequence and periodogram for TYC 8404-0354-1.

The photometric rotation period first measured by Messina et al. (2011) is confirmed by our analysis of the TESS data (Fig. A.73). Numerous flare events are detected in the TESS time series.

AU Mic = HIP 102409. The star has a prominent debris disk seen close to edge-on first spatially resolved by Liu (2004). A transiting planet at short period has been discovered with TESS (Plavchan et al. 2020). The photometric rotation period measured by Messina et al. (2010) is confirmed by our analysis of the TESS data (Fig. A.74). Numerous flare events are detected in the TESS time series.

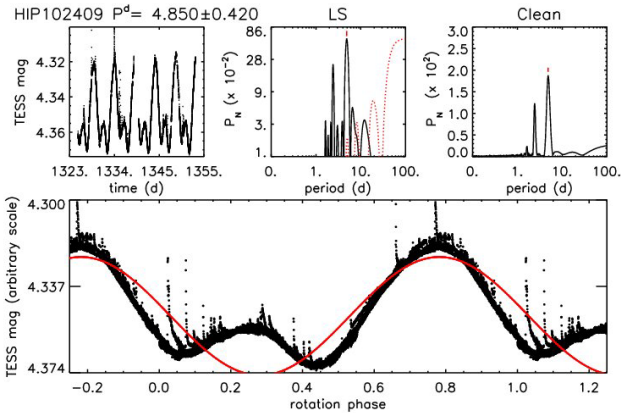

Fig. A.74. Photometric time sequence and periodogram for HIP 102409.

HIP 102626 = HD 197890 = BO Mic. Very fast-rotating star (P = 0.380 d; $v \sin i$ 128 km s^{-1}). This characteristic makes the determination of the spectral parameters difficult. Torres et al. (2006) determined a large Li EW, indicating a very young age. It was proposed by some studies (Kraus et al. 2014; Bell et al. 2015) to be a member of the Tuc-Hor association, but a very low probability is returned by the kinematic analysis including *Gaia* DR2. The controversial membership is linked to the wide dispersion of the astrometric parameters[17]. *Gaia* and HIPPARCOS parallaxes and even different HIPPARCOS reductions show large differences (up to 7.5 and 3.4 mas, respectively) while the proper motions derived from *Gaia* and HIPPARCOS differ by more than 20 mas yr^{-1}. The original HIPPARCOS reduction includes an astrometric acceleration trend, while *Gaia* DR2 notes the presence of a large excess of astrometric noise. This suggests the presence of a fairly massive stellar companion that was not revealed in any in the various direct imaging surveys that targeted this object (Chauvin et al. 2010; Galicher et al. 2016), including SHINE-SPHERE (see Paper II). Radial velocities are hardly conclusive because of the extreme $v \sin i$ value. Barnes (2005) discussed the possible spectroscopic companions compatible with the observational constraints. The isochrone age results very young when adopting *Gaia* DR2 parallax (4 Myr for the $T_{\rm eff}$ corresponding to the K3 spectral type by Torres et al. (2006); 8 Myr for the $T_{\rm eff}$ corresponding to the K2 spectral type indicated by broadband colors), but we consider this highly uncertain as the errors on parallax are possibly underestimated. The minimum radius from the observed rotation period and $v \sin i$ is 0.99 $R_\odot$. The inclination value of 70 deg proposed by Barnes (2005) through the Doppler imaging technique implies $R = 1.05 R_\odot$, compatible with a pre-main sequence star of early K spectral type. We conclude that membership in Tuc-Hor cannot be ruled out until the spread in the astrometric values and the possibility of binarity are better understood. The very strong lithium line in any case indicates an age younger than 100 Myr. We thus adopted the Tuc-Hor age, with min–max values of 5–100 Myr considering the various indicators.

The photometric rotation period measured by Kiraga (2012) is confirmed by our analysis of the TESS data (Fig. A.75).

TYC 1090-0543-1. Star with a low membership probability on AB Dor MG (8.8%) in spite of the previous kinematic

[17] When using the *Tycho*2 long-term proper motion coupled with the HIPPARCOS parallax, BANYAN returns a membership probability of 82.4% in Tuc-Hor.

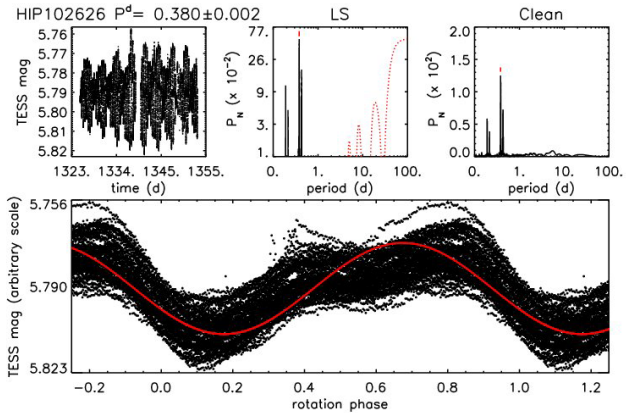

Fig. A.75. Photometric time sequence and periodogram for HIP 102626.

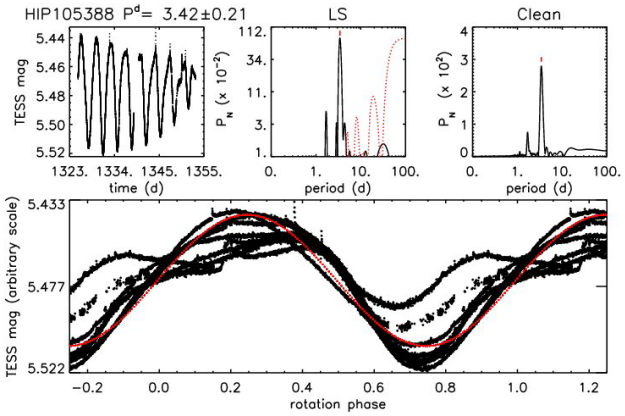

Fig. A.76. Photometric time sequence and periodogram for HIP 105388.

assignment (Torres et al. 2008). It is a wide companion of **HD199058**, which is itself a tight visual binary (Chauvin et al. 2015), making the system triple. Barenfeld et al. (2013) found the HD 199058 chemical pattern to be compatible with that of AB Dor core members. Lithium and the activity and rotation indicators of both components are compatible with those of AB Dor and Pleiades of similar spectral type.

HIP 104365 = HD 201184 = χ Cap. A0V star, flagged as a possible member of Tuc-Hor by Zuckerman & Song (2012). BANYAN Σ yields a 20% membership probability (80% field). We adopted the age from isochrone fitting, with the minimum value set at the minimum age of Tuc-Hor. This is in any case close to the lower limit allowed by stellar models. This is a triple system, as there is a close pair of comoving objects (Vigan et al. 2012) at 9″ labeled WDS 21 086-2112E and WDS 21 086-2112F. There is one corresponding entry in *Gaia* DR2, *Gaia* DR2 6832248844207846144, without astrometric parameters, likely because of the multiplicity.

HIP 105388. The photometric rotation period first measured by Messina et al. (2010) is confirmed by our analysis of the TESS data (Fig. A.76).

TYC 9482-121-1. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.77).

HIP 107345. The photometric rotation period first measured by Messina et al. (2010) is confirmed by our analysis of the TESS data (Fig. A.78). A large amplitude flare is detected in the TESS time series.

HIP 107350 = HD 206860 = HN Peg. The star has a low-mass brown dwarf companion at wide separation.

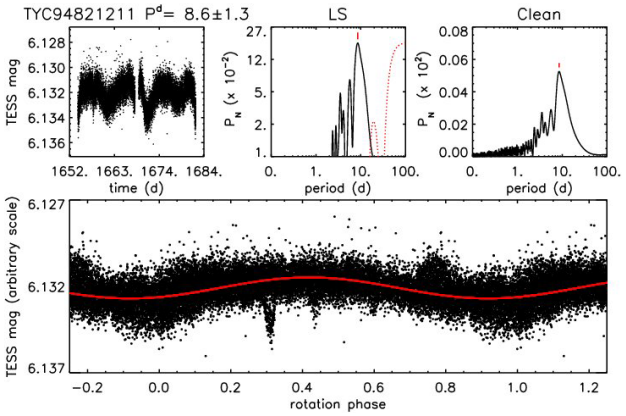

Fig. A.77. Photometric time sequence and periodogram for TYC 94 821 211.

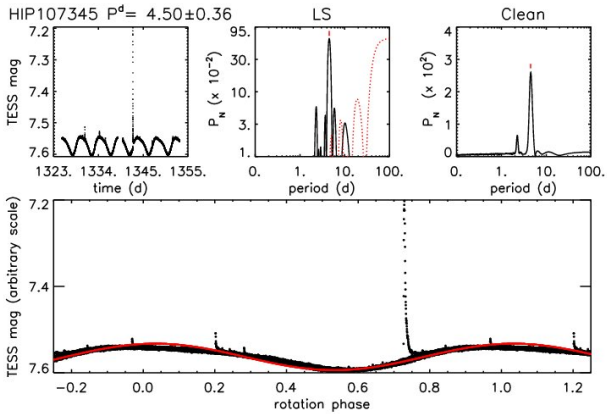

Fig. A.78. Photometric time sequence and periodogram for HIP 107345.

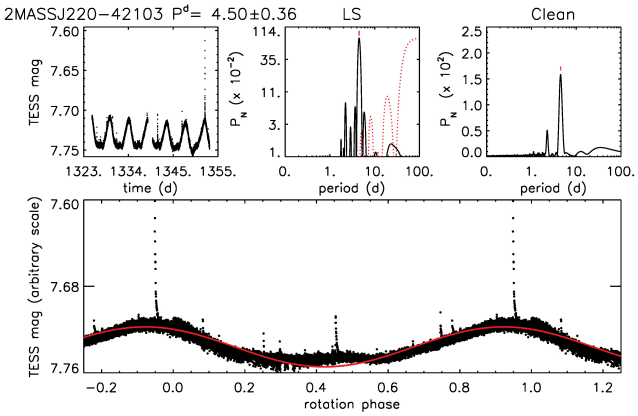

Fig. A.79. Photometric time sequence and periodogram for 2MASSJ220-42 103.

HIP 107412 = HD 206893. Star with a debris disk and with a substellar companion detected by Milli et al. (2017) and characterized by Delorme et al. (2017) and Grandjean et al. (2019) (see Delorme et al. 2017 for further details on stellar parameters).

2MASS J22021616-4 210 329. The photometric rotation period first measured by Kiraga (2012) is confirmed by our analysis of the TESS data (Fig. A.79). Numerous flare events are detected in the TESS time series.

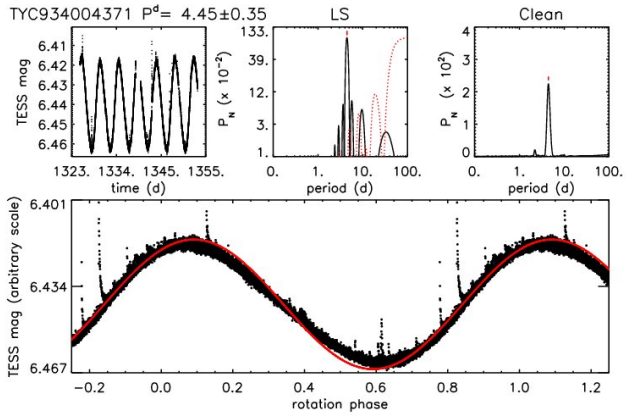

Fig. A.80. Photometric time sequence and periodogram for TYC 9340-0437-1.

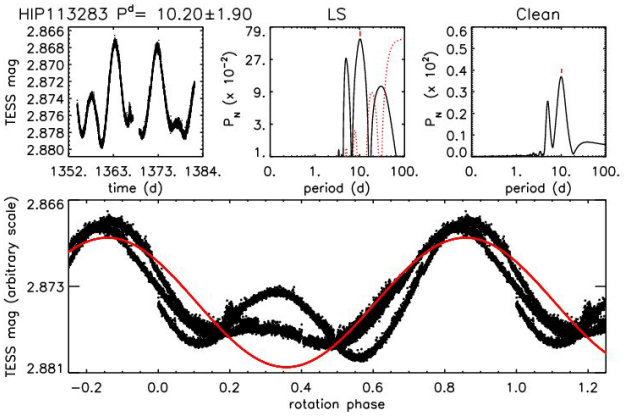

Fig. A.81. Photometric time sequence and periodogram for HIP 113283.

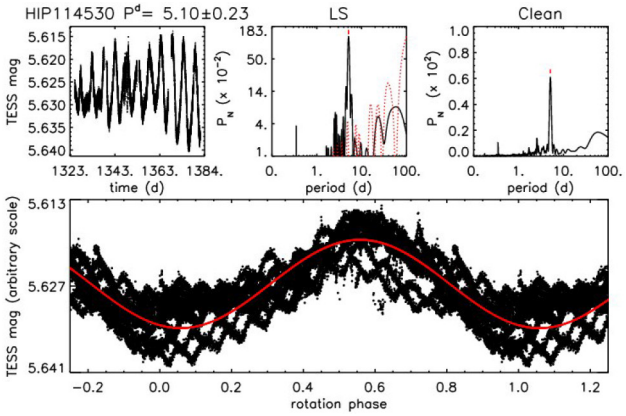

Fig. A.82. Photometric time sequence and periodogram for HIP 114530.

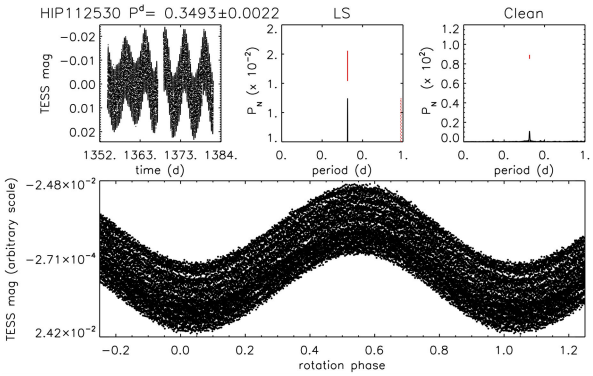

Fig. A.83. Photometric time sequence and periodogram for HIP 114530 after filtering out the $P = 5.10$ days rotational modulation.

TYC 9340-0437-1. Star with debris disk spatially resolved by *Herschel* observations (Tanner et al. 2020). The photometric rotation period first measured by Messina et al. (2010) is confirmed by our analysis of the TESS data (Fig. A.80). Numerous flare events are detected in the TESS time series.

HIP 113283 = TW PsA = Fomalhaut B. IR excess at 160 micron detected by Montesinos et al. (2016), but not seen at shorter wavelengths, indicating very cold dust. The star has a significant *Gaia*–HIPPARCOS proper motion difference. A dedicated search using imaging and radial velocities did not detect companions responsible for the astrometric signature De Rosa et al. (2019). Our even deeper imaging observations confirm this result. The age of the system is from Mamajek (2012). The photometric rotation period first measured by Busko & Torres (1978) is confirmed by our analysis of the TESS data (Fig. A.81).

Fomalhaut = HIP 113368. The age of the system is from Mamajek (2012). The controversial planet candidate Fomalhaut b Kalas et al. (2008); Janson et al. (2012); Lawler et al. (2015) is well outside the field of view of SPHERE.

HIP 114189 = HD 218396 = HR 8799. Star with the first multi-planetary system detected through imaging (Marois et al. 2008, 2010). It was proposed as a member of the Columba association by Marois et al. (2010). BANYAN returns a moderate membership probability (49%) to this group. Very recently, Lee & Song (2019) proposed it as a probable member of β Pic MG. A younger age would imply lower masses for the four planets orbiting the star. This would expand the extremely narrow space of parameters that fit the astrometric data ensuring at the same time dynamical stability (Esposito et al. 2013; Wang et al. 2018). We adopted the Columba age with a lower limit extending to β Pic MG age.

HIP 114530. The photometric rotation period first measured by Messina et al. (2010) is confirmed by our analysis of the TESS data (Fig. A.82). It is interesting to note that the light curve clearly shows evidence of a secondary small-amplitude periodicity superimposed on the $P = 5.10$ days rotation period. In Fig. A.83 we show that a period $P = 0.3493 \pm 0.0022$ day is detected by both Lomb–Scargle and Clean with a rotational modulation amplitude of about 0.02 mag. Considering the stability of the light curve phased with this short period, compared to the short timescale evolution of that phased with the longer period, we suspect that such a short periodicity does not arise from magnetic activity rather than the ellipsoidal effect of a likely close binary star observed within the TESS aperture radius.

HIP 114948. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.84).

HIP 118008. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.85).

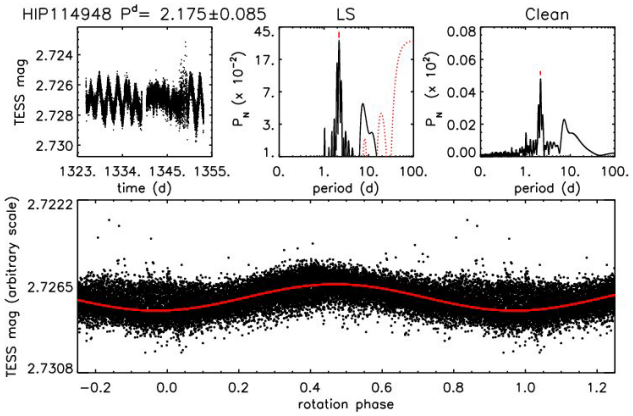

Fig. A.84. Photometric time sequence and periodogram for HIP 114948.

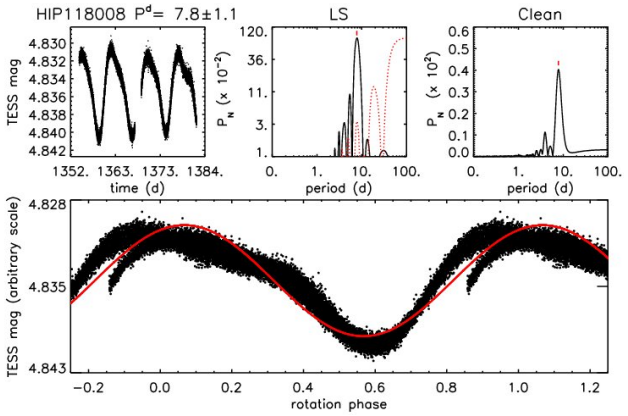

Fig. A.85. Photometric time sequence and periodogram for HIP 118008.