



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., Hamsch, 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., CASCONI, Enrico, CLAUDI, Riccardo, Costille, A., Deboulb�, 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., M�ller-Nilsson, O., Llored, M., Moulin, T., Orign�, 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

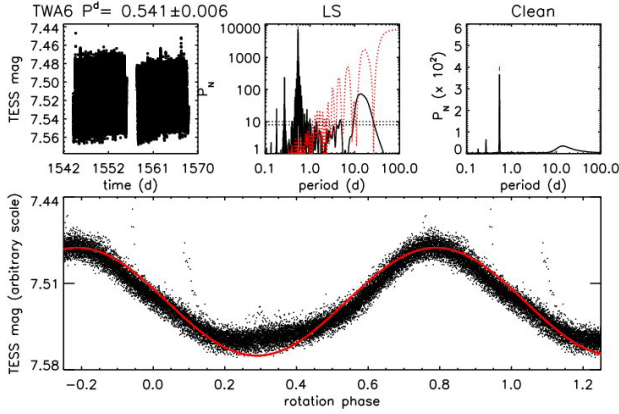


Fig. A.47. Photometric time sequence and periodogram for TWA6.

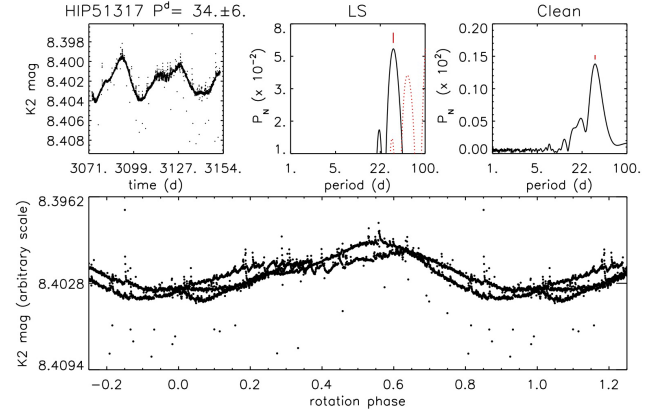


Fig. A.49. Photometric time sequence and periodogram for HIP 51317.

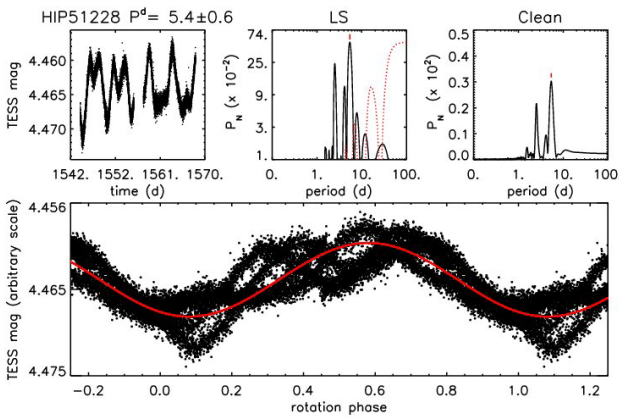


Fig. A.48. Photometric time sequence and periodogram for HIP 51228.

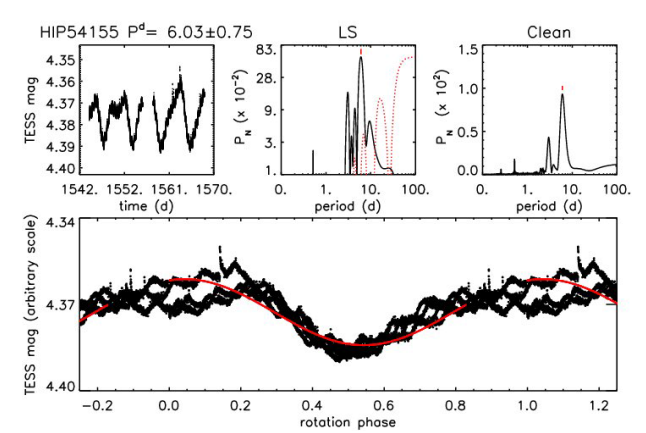


Fig. A.50. Photometric time sequence and periodogram for HIP 54155.

down to 50 Myr to include the possibility of Argus membership. The star has a significant IR excess (Zuckerman et al. 2011).

TWA 6 = GSC7183-1477 = BX Ant. Not member of TWA when using BANYAN *Gaia* DR2 parameters. On the other hand, the TWA membership is supported by Lee & Song (2019). In any case, independently of any kinematic evaluation, the very strong lithium unambiguously shows the very young nature of the star. Isochrone fitting yields an age of 10 ± 3 Myr, the same as the TWA group. The photometric rotation period first measured by Lawson & Crause (2005) is confirmed by our analysis of the TESS data (Fig. A.47).

HIP 51228. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.48).

HIP 51317. We measured for the first time the rotation period from the K2 Kepler photometric time series. (Fig. A.49).

HD 95086. Star with planetary companion first discovered by Rameau et al. (2013b). It is a Sco-Cen member according to de Zeeuw et al. (1999). BANYAN returns a 48.5% probability of membership in the Carina MG and 33.8% for LCC (without RV, the value listed in SIMBAD and several catalogs is the astrometric one by Madsen et al. 2002). The spatial position is in the outskirts of the Sco-Cen group. The age map by Pecaute & Mamajek (2016) yields an age of 26 Myr at the location of HD 95086, clearly older than the bulk of LCC. On the other hand, Schneider et al. (2019) recently proposed an age of 22 Myr for the Carina association. The isochrone age gives a lower limit of about 20 Myr for HD95086. Looking in *Gaia* DR2 for stars with similar position and kinematic parameters,

we noticed the F2 star HIP 55334 (HD 98660) with a lower age limit of about 19 Myr (our analysis and Pecaute et al. (2012)), consistent with the Pecaute & Mamajek (2016) age map. Our tentative conclusion is that HD 95086 is part of a young population that is slightly older than the bulk of LCC and possibly connected to the Carina association, or part of it. We adopted the age from the Pecaute & Mamajek (2016) map, with lower and upper limits corresponding to the LCC and Carina.

HIP 54155. The wide companion HD 96064B has no astrometric solution in *Gaia* likely due to its close binarity ($P = 23$ yr). The physical association of this triple system is nevertheless confirmed. The photometric rotation period first measured by Cutispoto et al. (1999) is confirmed by our analysis of the TESS data (Fig. A.50).

HIP 54231. Sco-Cen member according to de Zeeuw et al. (1999) and Rizzuto et al. (2011), but with low membership probability from BANYAN. We adopted the LCC age but with the upper limit derived by isochrone fitting (380 Myr). The literature spectral type is A0V, but the colors are more compatible with A1. The RV in SIMBAD is the expected value for membership (Madsen et al. 2002), not an observational measurement.

HIP 57632 = HD 102647 = β Leo. BANYAN returns an 87.1% membership probability to Argus, 4.6% to Carina-Near, and 8.3% for field. Argus membership is also supported by Zuckerman et al. (2011). We adopted Argus membership. There are no *Gaia* astrometric data due to the very bright magnitude. The star has a two-belt debris disk.

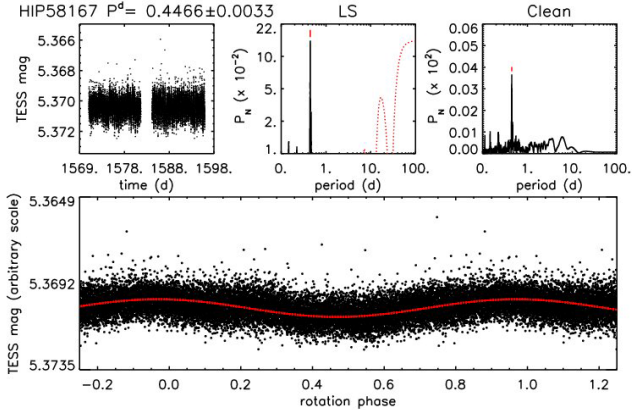


Fig. A.51. Photometric time sequence and periodogram for HIP 58167.

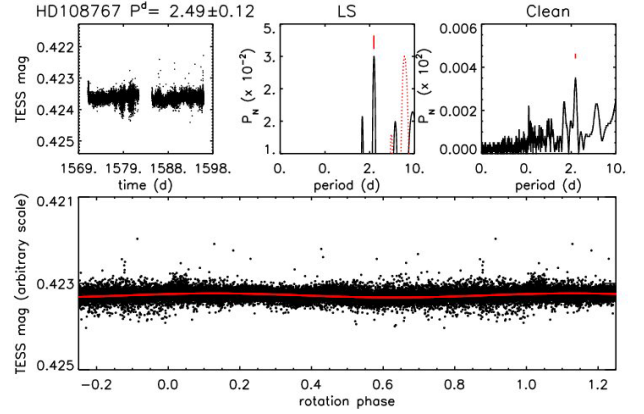


Fig. A.53. Photometric time sequence and periodogram for HD108767B.

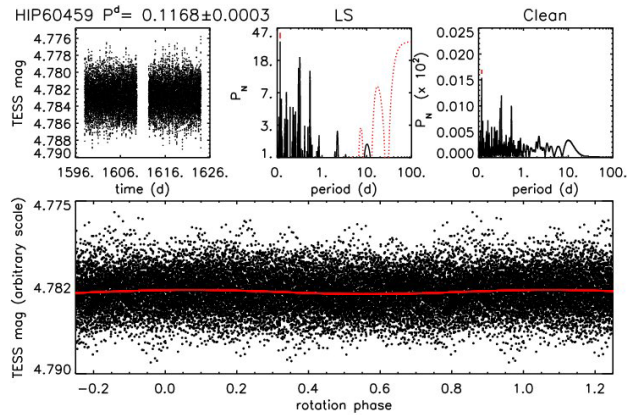


Fig. A.52. Photometric time sequence and periodogram for HIP 60459.

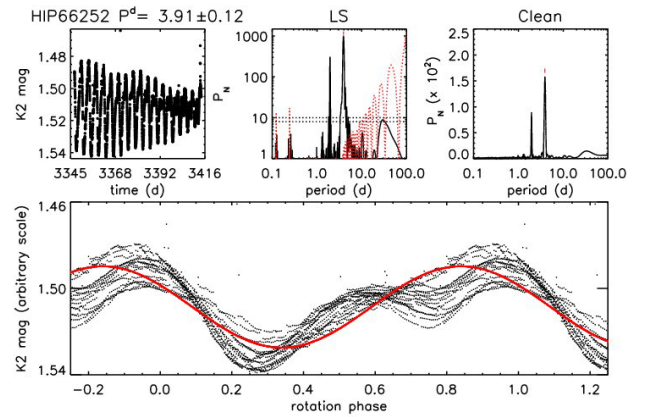


Fig. A.54. Photometric time sequence and periodogram for HIP 66252.

HIP 58167. F-type star in Sco Cen. The star has a comoving object (2MASS J11551267-5406215) with very similar astrometric parameters (proper motion difference of 1.6 and 1.2 mas yr^{-1} , parallax difference of 0.33 mas) in spite of the large projected separation (382'' corresponding to 41 250 au). From the 2MASS magnitudes, a mass as low as 20 M_{Jup} is derived for this object. In *Gaia* there is another possible comoving object, *Gaia* DR2 5344340167066548608 at 355'' (with a different position angle with respect to 2MASS J11551267-5406215). Its magnitude is extremely faint ($G = 20.99$) and it is not detected in 2MASS. The astrometric parameters are characterized by large errors (3.6 mas on parallax and more than 4 mas yr^{-1} on the components of proper motion). The object results comoving to HIP 58167 at about the 2σ level. If confirmed, the magnitude fainter than 2MASS J11551267-5406215 (by 2.5 mag) would imply an extremely low-mass object. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.51).

HIP 60183. The star is flagged as a member of LCC by de Zeeuw et al. (1999) and as a member of one of the LCC subgroups by Goldman et al. (2018); however it has however a low membership probability with Banyan. We adopted the LCC age, but with the upper limit derived from isochrone fitting.

HIP 60459. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.52).

HD 108767B. Wide companion to the B-type star δ Crv = HD108767. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.53).

HIP 61468. The star has a secondary at 15'', clearly comoving from the *Gaia* DR2 astrometry. To our knowledge, the binarity has not been previously reported in the literature. The companion (2MASS J12354637-4 101 315) is expected to have a spectral type of M3.5 from photometric colors, and is a possible X-ray source from CHANDRA (Wang et al. 2016).

HIP 66252. We measured for the first time the rotation period from K2 photometric time series (Fig. A.54).

TYC 7286-0248-1 = CD-31 11 053. K star with very strong lithium line identified by Torres et al. (2006). It is proposed as a possible member of UCL by Gagné et al. (2018b) on the basis of *Gaia* DR1 data, and inclusion of *Gaia* DR2 makes the case stronger (98% probability). Damiani et al. (2019) also support Sco-Cen membership. The RV difference between SACY and *Gaia* DR2 (8.8 km s^{-1}) is not highly significant considering the large error of *Gaia* RV (4.1 km s^{-1}). The discrepancy between photometric colors and spectral type (K3Ve, Torres et al. 2006) indicates either a significant reddening ($E(B - V) \sim 0.1$) or that the true spectral type is intermediate between K4 and K5. The lithium EW indicates an age at least as young as the β Pic MG. A very young age is also supported by the position on the CMD and the isochrone age, in spite of the ambiguity between effective temperature and reddening. These results are fully consistent with the UCL membership, which we then adopted.

HIP 69989 = HD 125451 = 18 Boo. Mid-F star classified as a possible UMa member by Montes et al. (2001) and King et al. (2003). Instead, BANYAN analysis rejected the membership.

We then considered the membership as unconfirmed. The age indicators are inconclusive considering the spectral type of the star. However, the chromospheric activity and X-ray emission are consistent with Hyades and UMa stars of similar temperature. The position on the CMD is close to ZAMS, with an upper limit of 1.9 Gyr. We adopted the UMa age with the upper limit from isochrone, as membership is uncertain. The star has RV monitoring by [Borgniet et al. \(2019\)](#) with SOPHIE. We used these data to provide a new value of absolute RV. The star also has an IR excess indicating a debris disk.

HIP 71724. A stellar companion (mass $146\text{--}217 M_{\text{jup}}$) at 101 mas was claimed by [Hinkley et al. \(2015\)](#). It was not detected in our observations, although it is expected to lie beyond the coronagraphic mask.

HIP 71743 = HD 128987 = KU Lib. G6V star whose age indicators (Li, Prot, X-rays, and RHK) nicely agree on an age close to that of the Hyades or slightly older. We adopted 700 ± 100 Myr. The star is classified as an extremely wide companion (separation of 1 pc) to the quadruple system α Lib ([Caballero 2010](#)). The membership to Castor MG is also proposed in that study.

HIP 73990 = HD 133803. The two brown dwarf companions at very small separations claimed by [Hinkley et al. \(2015\)](#) are not confirmed by SPHERE observations. See Paper II and Cantalloube et al. (in prep.) for further details. The star has a previously unrecognized wide companion (2MASS J15071795-2929501) at 5230 au projected separation.

HIP 74824 = HD 135379 = β Cir. A3V star with very wide brown dwarf companion ([Smith et al. 2015](#)) and IR excess. Analysis of kinematic parameters yields an 83% probability of being a member of β Pic MG when adopting the *Gaia* DR2 parameters. However, when adopting VL07 (which has smaller errors because of the very bright magnitude of the star), the membership probability drops to 19%. The star is slightly brighter than the ZAMS. Isochrone fitting yields ages of 450 ± 200 Myr and 8 ± 3 Myr assuming post- and pre-MS phases, respectively. The pre-MS age is not compatible with β Pic MG. Furthermore, the BD companion β Cir B does not show signatures of youth or low gravity ([Smith et al. 2015](#)). We then adopted the post-MS solution, yielding an age of 450 Myr.

HIP 76063 = HD 138204. A7 star classified as a Sco-Cen member (UCL subgroup) in [de Zeeuw et al. \(1999\)](#) and [Rizzuto et al. \(2011\)](#) (probability 55%). BANYAN Σ yield a 26.5% membership probability on UCL. The distance is significantly closer than the vast majority of the Sco-Cen population, as previously noted by [Wright & Mamajek \(2018\)](#). This rules out membership in the core of the Sco-Cen association, but a link with a foreground population of young stars of similar age (see, e.g. the bona-fide young star NZ Lup at 60 pc [Boccaletti et al. 2019](#)) is possible. We then adopted the isochrone age (220 Myr), extending the lower limit to encompass the UCL age. [Nielsen et al. \(2019\)](#) adopted instead the UCL membership and age.

HIP 77457. Member of US group according to [de Zeeuw et al. \(1999\)](#), while membership is rejected by [Pecaut et al. \(2012\)](#). Our analysis with BANYAN also gives a low membership probability in US (11%). We adopted the isochrone age, with lower limit at the US age to take the possible membership into account.

HIP 77464 = HD 141378. A-type star, possibly chemically peculiar, with a dual-belt debris disk. The low-mass

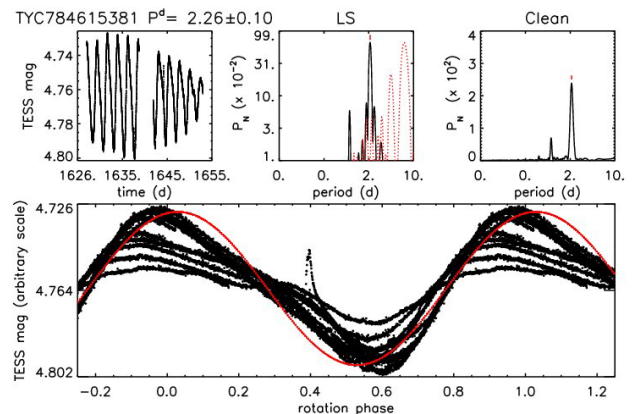


Fig. A.55. Photometric time sequence and periodogram for TYC 7846-1538-1.

star 2MASS J15490081-0348147 is a previously unrecognized wide companion at 4240 au.

TYC 7846 1538 1. The photometric rotation period first measured by [Marsden et al. \(2011\)](#) is confirmed by our analysis of the TESS data (Fig. A.55).

NZ Lup = HD 141943. See [Boccaletti et al. \(2019\)](#).

HIP 78099. The low-mass very wide companion 2MASS J15564019-2309291 was not previously associated with the primary, but was flagged as a bona fide Sco-Cen member ([Damiani et al. 2019](#)) and fast-rotating object ([Stauffer et al. 2018](#)).

HIP 78196 = HD 142851. A stellar companion (mass $98\text{--}152 M_{\text{jup}}$) at 74 mas was claimed by [Hinkley et al. \(2015\)](#). It was not detected in our observations, although it is expected to lie beyond the coronagraphic mask.

HIP 78530. Late B-type object with a brown dwarf companion at very wide separation discovered by [Lafrenière et al. \(2011\)](#).

HIP 78541 = HD 143488. Originally considered to be member of UCL [de Zeeuw et al. \(1999\)](#), it is possibly a field object (85.6% probability from BANYAN). We adopted the UCL age with upper limit from our isochrone fitting.

HIP 80591 = HD 148055. Star member of UCL. 2MASS J16271281-3949144 at $21.9''$ is a low-mass ($0.16 M_{\odot}$) companion, not previously mentioned in the literature as such.

HIP 81084. We measured for the first time the rotation period from photometric time series we collected at PEST observatory (Figs. A.56–A.57).

TYC 7879-0980-1 = HD 326277. First identified as a young star in [Torres et al. \(2006\)](#) and more recently classified as a UCL member by [Pecaut & Mamajek \(2016\)](#). *Gaia* DR2 kinematics coupled to BANYAN Σ confirms the UCL membership. The age indicators are fully compatible with this assignment. There is some discrepancy between the [Torres et al. \(2006\)](#) spectral type (K0IV) and the photometric colors, which would suggest instead a G7 star (from young stars [Pecaut & Mamajek 2013](#), tables). The isochrone ages for the temperatures corresponding to K0 and G7 are 14–24 Myr respectively, further supporting the young age and bracketing the nominal UCL age. There is a significant (3.1σ) proper motion difference between *Tycho2* and *Gaia* DR2, but no other indication of binarity.

HIP 82388. We measured for the first time the rotation period from the photometric time series we collected at the YCO observatory (Fig. A.58).

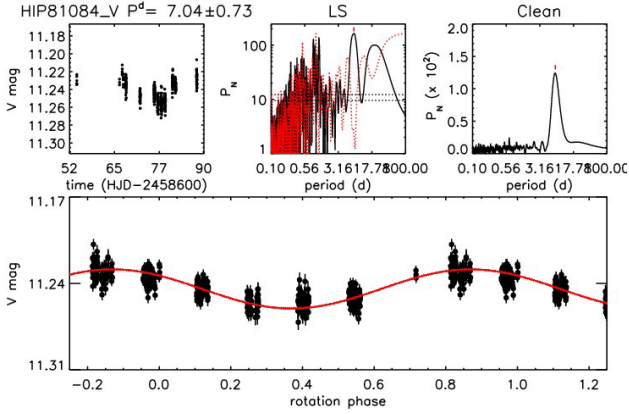


Fig. A.56. Photometric time sequence and periodogram for HIP81084 (V band).

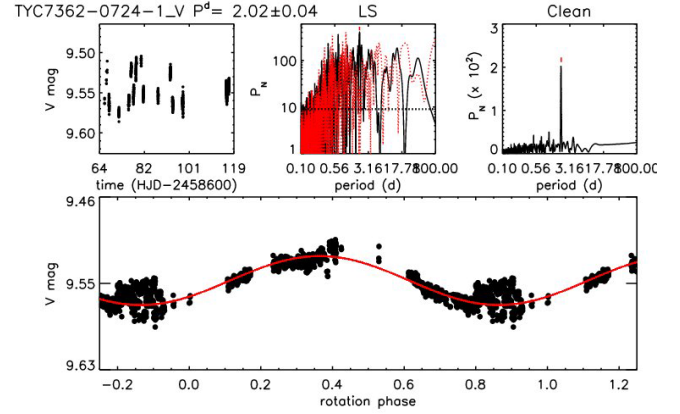


Fig. A.59. Photometric time sequence and periodogram for TYC 7362-0724-1 (V band; PEST data).

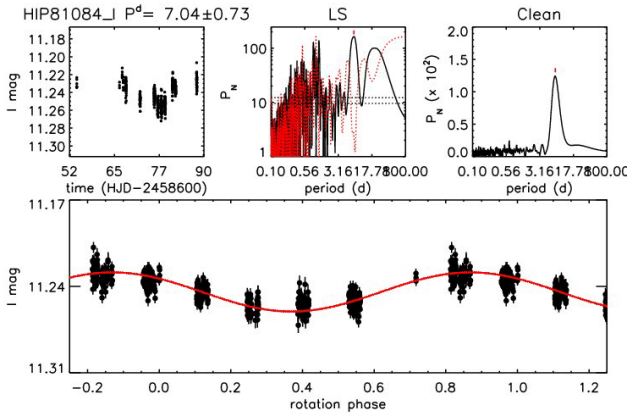


Fig. A.57. Photometric time sequence and periodogram for HIP 81084 (I band).

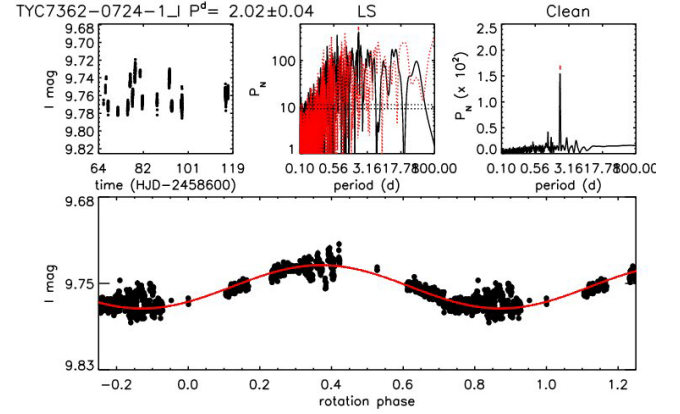


Fig. A.60. Photometric time sequence and periodogram for TYC 7362-0724-1 (I band; PEST data).

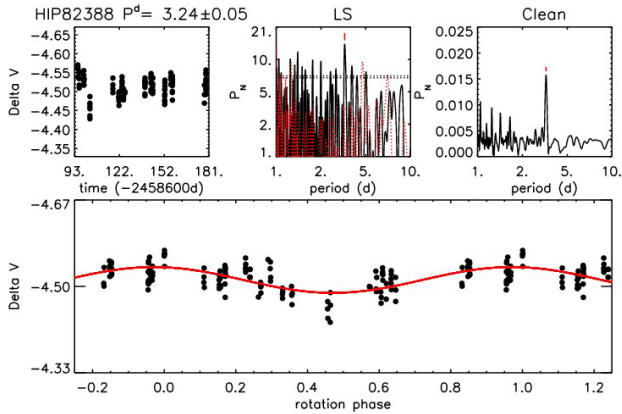


Fig. A.58. Photometric time sequence and periodogram for HIP 82388.

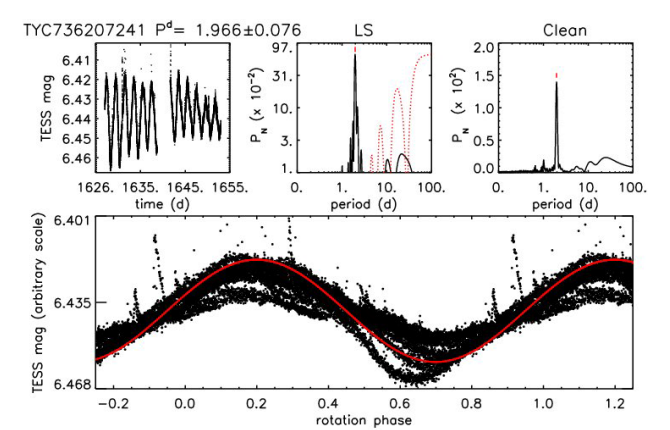


Fig. A.61. Photometric time sequence and periodogram for TYC 7362-0724-1.

TYC 7362-0724-1 = HD 156097. Young G5 star with strong lithium identified by Torres et al. (2006). The analysis based on the *Gaia* DR2 parameters yields a 46% membership probability to UCL and 13% to β Pic MG. Lithium and other indicators are fully compatible with a very young age (Desidera et al. 2015). Photometric colors are fully compatible with the G5 spectral classification by Torres et al. (2006). Adopting T_{eff} from the Pecaute & Mamajek (2013) tables, we infer an age of 11 ± 3 Myr, consistent but more accurate than that obtained from indirect methods. We adopted the

isochrone age, with UCL age as an upper limit due to the possible membership. We measured for the first time the rotation period from the photometric time series we collected at PEST, and subsequently confirmed by our analysis of the TESS data (Figs. A.59–A.60–A.61).

TYC 8728-2262-1. The photometric rotation period first measured by Messina et al. (2017) is confirmed by our analysis of the TESS data (Fig. A.62).

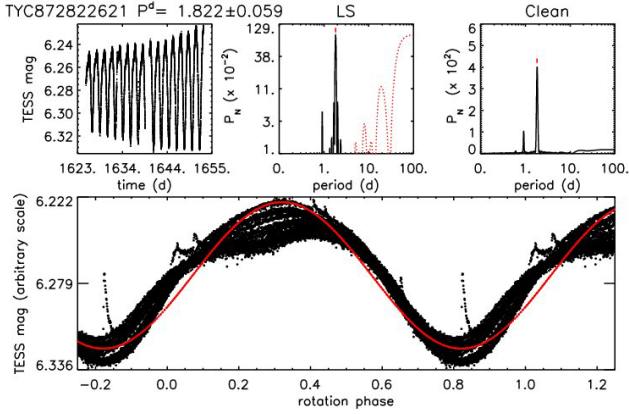


Fig. A.62. Photometric time sequence and periodogram for TYC 8728-2262-1.

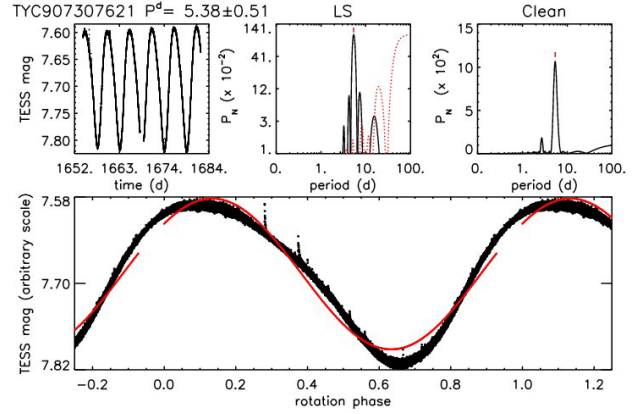


Fig. A.65. Photometric time sequence and periodogram for TYC 9073-0762-1.

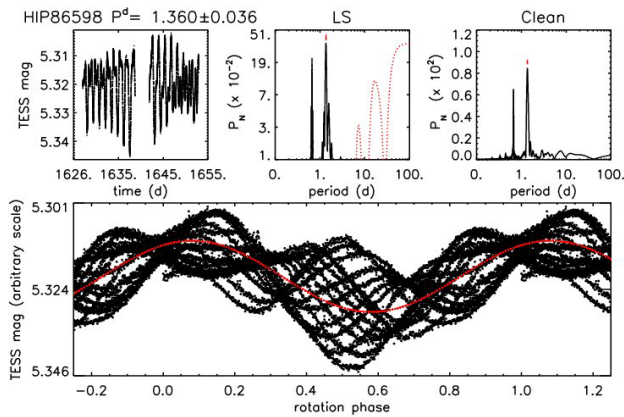


Fig. A.63. Photometric time sequence and periodogram for HIP 86598.

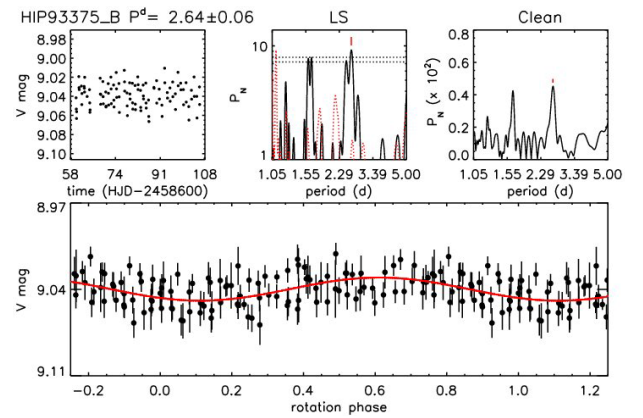


Fig. A.66. Photometric time sequence and periodogram for HIP 93375 (*B* band; ROAD data).

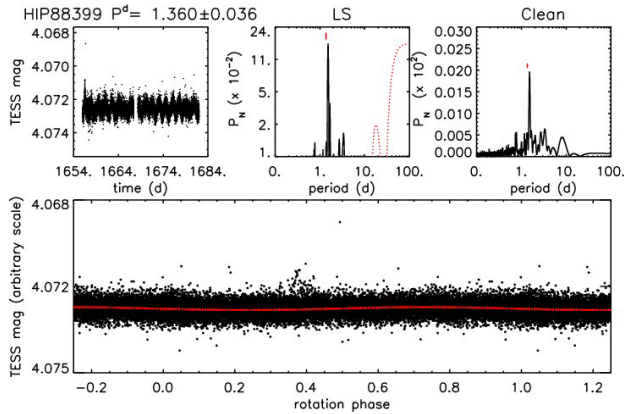


Fig. A.64. Photometric time sequence and periodogram for HIP 88399.

HIP 86598 = HD 160305. Star with debris disk spatially resolved from SHINE observations (Perrot et al. 2019) (see Fig. A.63 for the stellar rotation analysis).

HIP 88399. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.64).

TYC 9073-0762-1. The photometric rotation period first measured by Messina et al. (2010) is confirmed by our analysis of the TESS data. (Fig. A.65).

PZ Tel = HIP 92680 = HD 174429. Member of β Pic MG. It hosts a BD companion (PZ Tel B) discovered by Biller et al. (2010); Mugrauer et al. (2010) in a very eccentric orbit (Maire et al. 2016). The IR excess detected by Rebull et al. (2008)

has been shown to be due to a background object (Biller et al. 2013).

HIP 92984 = HD 175726. The star shows moderate activity and fast rotation. The star has kinematic parameters somewhat similar to UMa although with some differences causing low membership probability in BANYAN Σ . It also has an IR excess suggesting the presence of a debris disk. The age indicators quite consistently indicate that it is intermediate between the Hyades and Pleiades, independently of UMa membership. We adopted an age of 400 ± 200 Myr.

HIP 93375. As suspected in Desidera et al. (2015), *Gaia* DR2 astrometry shows conclusively that the star UCAC3 123-585 870 at 11'' is not physically associated. We measured for the first time the rotation period from the ROAD photometric time series in the *V* and *B* bands. (Fig. A.66-Fig. A.67).

TYC 8760-1468-1 = CD-54 8168. Field K2Ve object with very fast rotation and high Li content, similar to the members of the Tuc-Hor association. The RV in RAVE DR5 (Kunder et al. 2017) differs by 22 km s^{-1} with respect to the SACY value, but the error is very large (6 km s^{-1}). We thus consider it a suspected SB. The photometric rotation period first measured by Kiraga (2012) is confirmed by our analysis of the TESS data (Fig. A.68). The kinematic within the Zuckerman & Song (2004) “young box” is compatible with the young age estimated from lithium and rotation.

HIP 95270. We measured for the first time the rotation period from the TESS photometric time series (Fig. A.69).