J/A+A/591/A43 Differential rotation in solar-like stars (Distefano+, 2016)

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Lower limit for differential rotation in members of loose young stellar associations.

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=2016A&A...591A..43D (SIMBAD/NED BibCode)

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ADC_Keywords: Stars, late-type ; Associations, stellar ; Stars, distances ;
Effective temperatures ; Stars, masses
Keywords: stars: solar-type - starspots - stars: rotation -
galaxy: open clusters and associations: general -
techniques: photometric

Abstract:

Surface differential rotation (SDR) plays a key role in dynamo models and determines a lower limit on the accuracy of stellar rotation period measurements. SDR estimates are therefore essential to constrain theoretical models and infer realistic rotation period uncertainties. We measure a lower limit to SDR in a sample of solar-like stars belonging to young loose stellar associations with the aim of investigating how SDR depends on global stellar parameters in the age range (4-95Myr).

The rotation period of a solar-like star can be recovered by analyzing the flux modulation caused by dark spots and stellar rotation. The SDR and the latitude migration of dark-spots induce a modulation of the detected rotation period. We employed long-term photometry to measure the amplitude of such a modulation and to compute the quantity {Delta}{Omega}_phot_=2{pi}/P_min_-2{pi}/P_max_ that is a lower limit to SDR.

We find that {Delta}{Omega}_phot_ increases with the stellar effective temperature and with the global convective turn-over timescale tau_c_, which is the characteristic time for the rise of a convective element through the stellar convection zone. We find that {Delta}{Omega}_phot_ is proportional to T_eff_^2.18+/-0.65^ in stars recently settled on the ZAMS.

This power law is less steep than those found by previous authors, but closest to recent theoretical models.

We investigate how {Delta}{Omega}_phot_ changes in time in a 1M_{sun}_ star. We find that {Delta}{Omega}_phot_ steeply increases between 4 and 30Myr and that it is almost constant between 30 and 95Myr. We find also that the relative shear increases with the Rossby number Ro. Although our results are qualitatively in agreement with hydrodynamical mean-field models, our measurements are systematically higher than the values predicted by these models.

The discrepancy between {Delta}{Omega}_phot_ measurements and theoretical models is particularly large in stars with periods between 0.7 and 2d. Such a discrepancy, together with the anomalous SDR measured by other authors for HD 171488 (rotating in 1.31d), suggests that the rotation period could influence SDR more than predicted by the models.

Description:

The average rotation period, the parameters {omega}_min_, {omega}_max_, {Delta}{Omega}_phot_ and alpha_phot_ are reported for 111 late-type stars belonging to loose young stellar associations.

For each target, the main physical parameters are also reported. The Spectral types, the photometric data and the distances are taken by previous works. The masses, the effective temperatures and the convective turn-over time-scales have been inferred by comparing absolute magnitudes with different sets of theoretical isochrones.

File Summary:

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--------------------------------------------------------------------------------
 FileName      Lrecl  Records   Explanations
--------------------------------------------------------------------------------
ReadMe            80        .   This file
table2.dat        71      111   List of the target investigated in the present
                                 work
table3.dat        94      111   Results
table4.dat        62      111   Data used to compute absolute magnitudes
table5.dat        85      109   Stellar parameters inferred by the comparison
                                 of J and H magnitudes with different
                                 theoretical models
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See also:
   J/AJ/138/312  : Activity of bright solar analogs (Hall+, 2009)
   J/A+A/552/A78 : Solar like stars radial velocities (Zechmeister+, 2013)
   J/A+A/572/A34 : Pulsating solar-like stars in Kepler (Garcia+, 2014)
   J/A+A/520/A15 : RACE-OC project: YSOs within 100pc (Messina+, 2010)
   J/A+A/532/A10 : RACE-OC project. II. (Messina+, 2011)

Byte-by-byte Description of file: table2.dat
--------------------------------------------------------------------------------
   Bytes Format Units   Label     Explanations
--------------------------------------------------------------------------------
   1- 26  A26   ---     ID        ASAS or SuperwaspID (G1)
  29- 45  A17   ---     Name      Other designation
  46- 60  A15   ---     Assoc     Association
  61- 64  F4.2  mag     B-V       B-V colour index (2)
  66- 71  A6    ---     SpType    MK spectral type (2)
--------------------------------------------------------------------------------
Note (2): The colour indexes and spectral types have been taken from Messina
   et al. (2010, Cat. J/A+A/520/A15 and 2011, Cat. J/A+A/532/A10).
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Byte-by-byte Description of file: table3.dat
--------------------------------------------------------------------------------
   Bytes Format Units   Label     Explanations
--------------------------------------------------------------------------------
   1- 26  A26   ---     ID        ASAS or SuperWasp ID (G1)
  28- 32  F5.2  d       <P>       Average rotation period
  34- 39  F6.3  rad/d   omin      Lowest angular frequency
  41- 45  F5.3  rad/d e_omin      Error on lowest angular frequency
  47- 52  F6.3  rad/d   omax      Highest angular frequency
  54- 58  F5.3  rad/d e_omax      Error on highest angular frequency
  60- 64  F5.3  rad/d   DOp       {Delta}{Omega}_phot_ = omax-omin
  66- 70  F5.3  rad/d e_DOp       Error on DeltaOmega_phot
  72- 76  F5.3  ---     alphap    {alpha}_phot_ = (omax-omin)/omax
  78- 82  F5.3  ---   e_alphap    Errror on alpha_phot
  84- 86  I3    ---     Np        Number of time-series points
      89  A1    ---     fQ        [ABC] Quality flag (1)
  93- 94  A2    ---     fT        Time-series flag (2)
--------------------------------------------------------------------------------
Note (1): Quality flag as follows:
           A = stars with Np> 200
           B = stars with Np between 100 and 200
           C = stars with Np<100
Note (2): This flag indicates the time-series used to compute DeltaOmega_phot_.
--------------------------------------------------------------------------------

Byte-by-byte Description of file: table4.dat
--------------------------------------------------------------------------------
   Bytes Format Units   Label     Explanations
--------------------------------------------------------------------------------
   1- 26  A26   ---     ID        ASAS or SuperWasp ID (G1)
  29- 34  F6.2  mas     Plx       ?=- Parallax
  36- 42  F7.3  pc      Dist      Distance
  46- 50  F5.2  mag     DM        Distance modulus
  52- 55  F4.2  mag     JMAG      ?=- Absolute J magnitude (1)
  57- 60  F4.2  mag     HMAG      ?=- Absolute H magnitude (2)
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      62  I1    ---     Ref       [1/6] Reference (3)
--------------------------------------------------------------------------------
Note (1): This magnitude has been obtained by adding the Distance Modulus DM
  to the 2MASS J magnitude. The Distance Modulus has been inferred by using
  the parallax or the distance reported in other works
Note (2): This magnitude has been obtained by adding the Distance Modulus DM
  to the 2MASS H magnitude
Note (3): The reference number indicates the work from which the parallaxes
  and/or the distance have been taken, as follows:
         1 = Torres et al., 2006, Cat. J/A+A/460/695
         2 = Torres et al., 2008hsf2.book..757T
         3 = Perryman et al., 1997A&A...323L..49P
         4 = Zuckerman et al., 2000ApJ...544..356M
         5 = De Silva et al., 2013, Cat. J/MNRAS/431/1005
         6 = Murphy et al., 2013, Cat. J/MNRAS/435/1325
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Byte-by-byte Description of file: table5.dat
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   Bytes Format Units  Label      Explanations
--------------------------------------------------------------------------------
   1- 26  A26   ---    ID         ASAS or SuperWasp ID (G1)
  28- 31  F4.2  Msun   MSiess     Mass from Siess et al. (2000A&A...358..593S)
                                   models (1)
  36- 42  F7.2  K      TeffSiess  Effective temperature from Siess et al.
                                   (2000A&A...358..593S) models (1)
  44- 47  F4.2  Msun   MBar       ?=- Mass from Baraffe et al. (1998,
                                   Cat. J/A+A/337/403) models (1)
  50- 56  F7.2  K      TeffBar    ?=- Effective temperature from Baraffe et al.
                                   (1998, Cat. J/A+A/337/403) models (1)
  58- 61  F4.2  Msun   MSpada     ?=- Mass from Spada et al.
                                   (2013ApJ...776...87S) models (1)
  66- 72  F7.2  K      TeffSpada  ?=- Effective Temperature from Spada et al.
                                   (2013ApJ...776...87S) models (1)
  74- 79  F6.2  d      tauC       ?=- Turnover convective time-scale from
                                   Spada et al. (2013ApJ...776...87S) models (1)
  81- 85  F5.3  ---    Ro         ?=- Rossby number (2)
--------------------------------------------------------------------------------
Note (1): Stellar parameters inferred by the comparison of the J and H
  magnitudes with the theoretical isochrones of Siess et al.
  (2000A&A...358..593S), Baraffe el al. (1998, CaT. J/A+A/337/403) and
  Spada et al. (2013ApJ...776...87S).
Note (2): The Rossby Number is computed as Ro=<P>/tau_C_
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Global notes:
Note (G1): ASAS_JHHMMSS+DDMM.m or SWASP1_JHHMMSS.SS+DDMMSS.s
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    Elisa Distefano, eds(at)oact.inaf.it

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(End)                                        Patricia Vannier [CDS]  15-Apr-2016
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