Curriculum vitae et studiorum of IGNAZIO PILLITTERI

Personal data:

- Name: Ignazio Pillitteri.
- Birth place and date: Catania (Italy), April 16th 1972.
- Nationality: Italian.
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- E-mail address: pilli@astropa.unipa.it
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- Research topics: X-ray activity in young stars and star forming regions.
- Current position: post-doc fellow at the University of Palermo (Università degli Studi di Palermo.).

Education

- Degree ("laurea") in Physics at the Università degli Studi di Palermo, date: 28/02/2001.
- PhD in Physics at the Università degli Studi di Palermo, date: 07/02/2005.
- Foreign languages: English, french.

Schools in Astrophysics:

* 29/05/2000 – 3/06/2000: Scuola Nazionale di Astrofisica (National school in Astrophysics), V cycle - III course, held in Palermo (ITALY); topics: Astrophysical Plasmas - Novae e Supernovae;
* October 13–19 2001: Scuola Nazionale di Astrofisica, VI cycle – II course, held in Trieste (ITALY), topics: Chemical Evolution of Galaxies – High Resolution spectroscopy.
* May 11–17 2003: Scuola Nazionale di Astrofisica, VII cycle – I course; topics: "Galaxies in the Local Group – Next generation telescopes", held in Marciana Marina (ITALY).

Computer expertises.

- operative systems: UNIX, LINUX, SUNOS-Solaris, MS DOS, MS Windows.
- programming languages: FORTRAN, C (basic knowledge)
- basic knowledge of computer networks (Internet)

- Astronomical software for data reduction and analysis: SAS, XSPEC, IRAF, ftools, ds9, MIDAS, FLAMES-Giraffe/Uves data reduction pipelines (Midas environment), MOOG, SPECTRE, ATLAS9

- Generic Analysis and statistical software: R, IDL, S-plus.

- Text editing and visualization tools: LaTeX, MS Word, MS PowerPoint, Open Office suite

Curriculum vitae.

- 28/02/2001: Degree in Physics (laurea)

- 18/04/2001-5/05/2001 e 26/08/2001 - 08/09/2001: scientific collaboration (supervisor: Dr. F. Favata) at ESA-ESTEC research center, Noordwijk - The Netherlands

- July 2001: beginning of the Ph. D. course at University of Palermo

- April 2003: participation to the congress: "Eddington 2nd International Workshop", Palermo, Italy.

- October 14–16 2003: oral contribution to the "EPIC Consortium Meeting", Palermo, Italy.

- June 2004: end of Ph. D. course and admission to the thesis dissertation

- November 2004: post-doc fellowship at Università degli Studi di Palermo

- February 2005: PhD thesis dissertation

- September 2005: Participation to the congress: "X-ray Universe 2005", San Lorenzo el Escorial, Spain, Sept 26-30 2005

- November 2006: renewal of the fellowship position at Univ. Studi di Palermo

- May 2008: Participation to the congress: "X-ray Universe 2008", Granada, Spain

- July 2008: Participation to the congress: "Cool Stars XV", St. Andrews, Scotland - UK

Scientific publications on refereed journals.

1. *"The X-ray Luminosity Distributions of the High-Metallicity Open Cluster Blanco 1."*, **I. Pillitteri**, G. Micela, S. Sciortino e F. Favata 2003, A&A 399 p. 919

2. *"The photospheric abundances of active binaries. II. Atmospheric parameters and abundance patterns for 6 single-lined RS Cvn systems."*, T. Morel, G. Micela, F. Favata, D. Katz e **I. Pillitteri**, 2003 A&A, 412, p. 495.

3. *"XMM-Newton observations of the young open cluster Blanco 1. I. X-ray spectroscopy and photometry."*, **I. Pillitteri**, G. Micela, S. Sciortino, F. Damiani e F. R. Harnden Jr. 2004, A&A 421 p. 175.

4. *"XMM-Newton observations of the young open cluster Blanco 1. II. X-ray time variability and flares."*, **I. Pillitteri**, G. Micela, F. Reale e S. Sciortino, 2005, A&A 430 p. 155.

5. *"X-ray spectral and timing characteristics of the stars in the young open cluster IC 2391"*, A. Marino, G. Micela, G. Peres, **I. Pillitteri** e S. Sciortino, 2005, A&A 430 p. 287.

6. *"Deep X-ray survey of the young open cluster NGC 2516 with XMM-Newton"*, **I. Pillitteri**, G. Micela, F. Damiani e S. Sciortino, A&A 2006, 450 p. 993.

7. *"X-ray variability of NGC 2516 stars in the XMM-Newton observations"*, A. Marino, G. Micela, **I. Pillitteri**, G. Peres, 2006 A&A 456, p. 977.

8. *"The XMM-Newton survey of the ELAIS-S1 field. I. Number counts, angular correlation function and X-ray spectral properties"*, S. Puccetti, F. Fiore, V. D'Elia, **I. Pillitteri**, C. Feruglio, A. Grazian, M. Brusa, P. Ciliegi, A. Comastri, C. Gruppioni, M. Mignoli, C. Vignali, G. Zamorani, F. La Franca, N. Sacchi, A. Franceschini, S. Berta, H. Buttery, J. E. Dias, 2006 A&A, 457, p. 501

9. *"The XMM-Newton Extended Survey of the Taurus Molecular Cloud (XEST)"* M. Guedel, K. R. Briggs, K. Arzner, M. Audard, J. Bouvier, E. D. Feigelson, E. Franciosini, A. Glauser, N. Grosso, G. Micela, J. Monin, T. Montmerle, D. Padgett, F. Palla, **I. Pillitteri**, L. Rebull, L. Scelsi, B. Silva, S. L. Skinner, B. Stelzer, A. Telleschi, 2007 A&A 468 p. 353.

10. *"Spectral properties of X-ray bright variable sources in the Taurus Molecular Cloud"*, E. Franciosini, **I. Pillitteri**, B. Stelzer, G. Micela, K. R. Briggs, L. Scelsi, A. Telleschi, M. Audard, M.; F. Palla, M. Guedel, 2007 A&A, 468 p. 485.

11. *"A statistical analysis of X-ray variability in pre-main sequence objects of the Taurus Molecular Cloud"*, B. Stelzer, E. Flaccomio, K. R. Briggs, G. Micela, L. Scelsi, M. Audard, **I. Pillitteri**, M. Guedel, 2007 A&A, 468 p. 463.

12. *"New Pre-Main Sequence Candidates in the Taurus-Auriga Star Forming Region"*, L. Scelsi, A. Maggio, G. Micela, **I. Pillitteri**, B. Stelzer, K. R. Briggs, M. Güdel, N. Grosso, e F. Palla, 2007, A&A 468 p. 405.

13. *"VLT/Flames observations of the star forming region NGC 6530"*, L. Prisinzano, F. Damiani, G. Micela, **I. Pillitteri**, 2007, A&A, 462 p. 123.

14. *"X-ray flares on the UV Ceti-type star CC Eridani: a peculiar time-evolution of spectral parameters"*, I. Crespo-Chacón, G. Micela, F. Reale, M. Caramazza, J. López-Santiago e **I. Pillitteri**, 2007, A&A 471 p. 929.

15. *"Results from Droxo. I. The variability of fluorescent Fe 6.4 keV emission in the young star Elias 29"*, G. Giardino, F. Favata, **I. Pillitteri**, E. Flaccomio, G. Micela, e S. Sciortino, 2008 A&A, 475 p. 891.

16. *"The X-ray luminosity of solar-mass stars in the intermediate age open cluster NGC 752"*, G. Giardino, **I. Pillitteri**, F. Favata, G. Micela, 2008, A&A in press, arXiv:0808.3451

17. "Optical spectroscopy of X-ray sources in the Taurus molecular cloud: discovery of ten new pre-main sequence stars", L. Scelsi, G. Sacco, L. Affer, C. Argiroffi, **I. Pillitteri**, A. Maggio, G. Micela, 2008 A&A in press, arXiv:0809.2171

18. *"Results from DROXO. [Ne II] and X-ray emission from ρ Ophiuchi young stellar objects"*, E. Flaccomio, B. Stelzer, S. Sciortino, G. Micela, **I. Pillitteri**, L. Testi, 2008 A&A submitted.

Oral contributions and posters.

1. *"The X-ray Luminosity Functions of the young open cluster Blanco 1"*, **I. Pillitteri**, G. Micela, S. Sciortino e F. Favata, poster contribution "X-ray Astronomy 2000", Palermo (Italy) Sept 4-9 2000.

2. *"X-ray Luminosity Functions of the young open cluster Blanco 1"*, **I. Pillitteri**, G. Micela, S. Sciortino e F. Favata, oral contribution *"JENAM 2001"*, Munich (Germany), Sept 10–14 2001, *Astronomische Gesellschaft Meeting Abstracts*, 2001 p. 714

3. *"Short and medium term variability study of NGC 2516 solar type stars with EPIC"*, **I. Pillitteri**, G. Micela, A. Marino e S. Sciortino, oral contribution *"EPIC Consortium Meeting"*, Palermo (Italy), Oct 14–16 2003, *"Memorie della Società Astronomica Italiana"* 2004, 75, p. 440

4. *"X-ray observations of the young open cluster Blanco 1. The XMM-Newton view."*, **I. Pillitteri**, G. Micela, S. Sciortino, F. Damiani, F. Reale e F. R. Harnden Jr., Hamburg (Germany) July 4–9 2004, poster contribution *"Cool Stars nr. 13"*,

5. *"X-ray spectral and timing properties of the IC 2391 stars"*, A. Marino, G. Micela, G. Peres, **I. Pillitteri**, S. Sciortino, poster contribution *"Cool Stars nr. 13"*, Hamburg (Germany) July 4–9, 2004.

6. *"Study of the young open cluster IC2391: discovery of X-ray rotational modulation in a supersaturated star"* G. Micela, A. Marino, G. Peres, **I. Pillitteri**, S. Sciortino, oral contribution *"EPIC Consortium Meeting"*, Palermo (Italy), Oct 14–16 2003, *"Memorie della Società Astronomica Italiana"* 2004, 75, p. 442

7. *"The photospheric abundances of active binaries: first results."* T. Morel, G. Micela, F. Favata, D. Katz e **I. Pillitteri**, poster contribution *"IAU Symposium 219. Stars as Suns: activity, evolution and planets."*, Sidney (Australia), July 21–25 2003, *"ASP Conference Series"*.

8. *"The Deep Rho Ophiuchi XMM Observation (DROXO)"*, S. Sciortino, **I. Pillitteri**, E. Flaccomio, G. Micela, F. Favata et al. 2005, poster contribution *"The X-ray Universe 2005"*, San Lorenzo El Escorial (Spain), Sept 26–30 2005.

9. *"Results from the Deep Rho Ophiuchi XMM-Newton Observation (DROXO)"*, S. Sciortino, **I. Pillitteri**, N. Grosso, F. Damiani, E. Flaccomio, G. Micela, B. Stelzer, F. Favata, G. Giardino, T. Montmerle, F. Palla e L. Testi, poster contribution *"Cool Stars N. 14"*, Pasadena (USA), Nov 6-11 2005.

10. *"X-ray properties of sources detected in the DROXO survey"*, **I. Pillitteri**, F. Favata, G. Giardino, N. Grosso, G. Micela, T. Montmerle, S. Sciortino, B. Stelzer, L. Testi, poster contribution *"Cool Stars XV"*, St. Andrews (UK), July 20–25 2008.

Research activity

My research has been focused mainly on the study of X-ray activity in stellar open clusters and star forming regions

X-ray activity in stellar open clusters.

X-ray activity of late type stars is thought to be generated by hot plasma emission. The plasma is magnetically confined in coronal loops and the magnetic field is created by the dynamo. In turn, dynamo is produced by the interaction of convective motions and stellar rotation. Stellar X-ray activity decreases with age because the dynamo becomes less efficient as a consequence of the angular momentum losses. Open clusters are naturally selected star samples in which we can study the influence of the various physical stellar properties.

In particular, I have studied the X-ray activity of stars in the young open clusters *Blanco 1*, *NGC 2516* and *NGC752*.

Blanco 1 is an interesting open cluster because of its age very similar to the well known Pleiades, and its location somewhat high on the Galactic disk. Its properties allow us to study the X-ray activity of young stars with high metal content and, perhaps, different origin with respect to typical open clusters, like e.g. the Pleiades. I have studied the X-ray emission by means of ROSAT and XMM-Newton data. One of the main results of my analysis is a slightly higher X-ray luminosity level in M-type stars of Blanco 1 with respect to M-type stars in Pleiades. On the contrary, the distribution of X-ray luminosities of G- and K-type stars is quite similar to that of the Pleiades, thus suggesting a role of metallicity in determining the X-ray activity level in M-type stars with high metal abundances. The coronal spectra of solar mass stars are characterized by two main plasma thermal components, whereas the coronal spectrum of intermediate mass stars is described with only one temperature and it is noticeably cooler than late type star coronae. X-ray light curves in Blanco 1 present a high fraction of variable stars, especially among very low mass stars. Flares are the common features of light curves but in some cases smooth modulations are observed. By comparing XMM-Newton and ROSAT data, variability on time scales of $\sim$ 6 yr is generally smaller than a factor of two, thus lacking evidence of stellar cycles analog to the solar ones in young stars.

NGC 2516 is a rich, young open cluster, observed several times by XMM-Newton. I have used these data in order to study the X-ray photometry of the cluster with unprecedented depth and to assess the X-ray variability on time scales of hours and months. X-rays time variability on short time scales is more enhanced in very low mass stars with respect to solar mass stars, as we observed in Blanco 1. The comparison of X-ray luminosities of G-type stars on a interval of $\sim$ 20 months shows variability amplitude significantly lower than those expected in the Sun for the presence of the 11-yr cycle. Hence, also in this case, if cycles are present in young stars, they have characteristics different from those of the solar one.

Code for source detection on XMM-Newton data. As support to the analysis of Blanco 1 and NGC 2516 XMM-Newton data, I have participated to the development and calibration of a software for the simultaneous source detection on several PN and MOS exposures based on Wavelet transform technique. It is is derived from the version designed for ROSAT (Damiani et al., 1997) and Chandra. The code allows us to process several images of the same target at the same time, maximizing thus the detection efficiency toward faint sources.

It has a multi-scale approach, which is suited for both point and extended sources in the same field of view. The MOS and PN images in input are re-scaled to a common reference instrument and the X-ray photometry is derived in terms of an equivalent exposure with that instrument.

NGC 752 is a open cluster with age of 1.9 Gyr, which is intermediate between that of Hyades ($\sim$ 0.8 Gyr) and the Sun (4.6 Gyr) and thus allows us to determine the X-ray emission decline in this range of age. We analyzed a *Chandra* and *XMM-Newton* observations deriving thus the the X-ray luminosity of all observed cluster members (28 stars) and of 11 cluster member candidates. We find that, at an age of 1.9 Gyr, the typical X-ray luminosity of the cluster members with M= $0.8 - 1.2 M\odot$ is $L_X = 1.3 \cdot 10^{28}$erg s^{-1}, so approximately a factor of 6 less intense than that observed in the younger Hyades. Given that L_X is proportional to the square of a star rotational rate, the median L_X of NGC 752 is consistent, for t $\geq$ 1 Gyr, with a decaying rate in rotational velocities $v_{rot} \propto t^{-\alpha}$, where $\alpha \sim 0.75$, is steeper than the Skumanich relation ($\alpha \sim 0.5$) and significantly steeper than observed between the Pleiades and the Hyades ages (where $\alpha \sim 0.3$), suggesting that a change in the rotational regimes of the stellar interiors is taking place at t $\sim$ 1 Gyr.

X-ray emission from star forming regions

I have participated to the XMM-Newton large programs XEST and DROXO aimed to study the X-ray emission and its origin in the Taurus (P.I. M. Guedel) and ρ Ophiuchi Clouds (P.I. S. Sciortino).

XEST. The XEST survey has observed and studied 23 fields in the Taurus Molecular Cloud (TMC) with XMM-Newton. A series of papers have detailed the results ranging from the global properties of X-ray emission in relation to the stellar properties to the presence of mass accretion and outflows, the correlation with rotation and the time variability. I have participated to the data analysis of all datasets and I have studied the time variability of the brightest sources. The light curves of the selected sources show different types of variability: flares, long-lasting decay or rise through the whole observation, and slow modulation or complex flare-like variability. The spectral analysis shows typical quiescent plasma temperatures of $\sim 5 - 10$ MK and $\sim 15 - 35$ MK; the cool component generally remains constant, while the observed flux changes are due to variations of the hot component. During flares the plasma reaches temperatures up to 100 MK and luminosities up to $\sim 10^{31}$ erg s^{-1}. Loop sizes inferred from flare analysis are generally smaller than or comparable to the stellar radius.

DROXO. The DROXO program aims to investigate the dense core F of the ρ Ophiuchi Cloud with a $\sim$ 500 ks almost continuous observation taken with XMM-Newton. The focus is on the mechanisms that create the X-ray emission in very young ($\sim$ 1Myr) Pre Main Sequence stars and protostars and the study of rapid variability. With DROXO we explore the origin of X-rays in YSOs and the interplay between star and circumstellar disk in PMS phase. A complementary campaign of IR spectroscopy at ESO VLT has been obtained within the DROXO program.

The DROXO sources show the saturation of log L_X/Lbol ratio at ~ -3 for PMS stars with mass around 0.7 M$\odot$ and T_{eff} = 5000 K. Most of the source spectra are well modeled with a single absorbed thermal component. The median of plasma temperatures is $\sim$ 1.9 keV and that of absorption column is $\sim 2. \cdot 10^{22}$ cm^{-2} (Pillitteri et al., in prep., Pillitteri et al.

2005, 2008). We have observed the fluorescent Fe line at 6.4 keV in a few objects, like Elias 29. In this Class II YSO the line is strongly visible in a part of the observation while it faints in subsequent times (Giardino et al., 2007). This variability is not related to strong flare activity. In the star YLW16A the line appear variable too, being fainter in DROXO spectra than in previous Chandra observations (Imanishi et al., 2001). The Spitzer counterparts of eleven DROXO X-ray sources show the infrared Ne II and Ne III line at 12.81 and 15.55 μm, respectively (Flaccomio et al, 2008 A&A submitted). Theoretical models predict these lines generating from the heating action and the ionization process of X-rays onto the disk surface. The comparison of X-ray luminosities and Ne line fluxes do not show a correlation, being line fluxes 1-2 dex higher than predicted by models at these X-ray emission level. However, we found a correlation between line fluxes and mass accretion derived from IR spectra we obtained at ESO thus pointing to a role for the UV emission to contribute to the Ne line formation. We conclude that the X-ray irradiation onto disks is not the only cause for the Ne line formation, theoretical models of irradiated circumstellar disk should include other physical components such as the envelope, inflows and outflows.

Optical spectroscopy.

Stellar activity influences the absorption depth of strong lines which cores are formed in the chromosphere. In my degree thesis, I have studied low resolution spectra of low mass stars in Blanco 1 (an optical follow-up of ROSAT unidentified X-ray sources) and, for comparison, Pre-Main-Sequence stars of Scorpius-Centaurus region. Spectra of Blanco 1 stars have been obtained at the ESO 1.5m telescope and B&C single order spectrograph. I have used these spectra to classify the spectral types by comparison with a spectral library, and to measure Hα and Ca II infrared triplet as activity indicators. In the same framework I have analyzed *echelle* spectra of stars of Pleiades and α Persei clusters and stars in Taurus-Auriga and Stock 2 regions in order to measure Ca II infrared triplet in Pre-Main-Sequence and Main-Sequence stars. Subsequently, I have analyzed high resolution spectra of active stars in binary systems in order to derive the photospheric abundances, and to compare them with the coronal abundances. Furthermore, I have participated to setup an analysis method that can lead to reliable estimates of abundances and errors. To complement my studies, from FLAMES observations I have derived radial velocities, rotational velocities and lithium abundances A(Li) in Blanco 1. Radial velocities have been used as a further membership criterion, rotational velocities have been used to evaluate the fraction of fast rotators in K-type stars. Measurements of A(Li) are important for the connection between convective zone depth and magnetic activity. The lithium is depleted in late type stars because of the mixing in the convective zone. This in turn is a key ingredient of magnetic dynamo, thus making a connection between corona and internal stellar structure. Blanco 1 exhibits the same spread and trend of A(Li) in stars with $T_{\rm eff}$ below $\sim$ 5300 K like in the coeval Pleiades. I have participated to the analysis of FLAMES spectra of the very young NGC 6530 and of the old Collinder 261 open clusters to derive Li abundances and radial velocities.