

Eleonora Fiorellino



Title

The mass of young stars like to play hide & seek

Abstract

A fundamental question in astrophysics is how stars get their mass. We know that low-mass stars form from the collapse of self-gravitating prestellar-cores. Since this collapse, young stellar objects (YSOs) acquire mass through the magnetospheric accretion process for up to 10Myr. According to this scenario, the material falls from the envelope through the circumstellar disk onto the central forming-star, following the magnetic field lines. Thanks to new facilities, it has been possible to observe spectroscopically the inner part of the circumstellar disks in the nearby star forming clouds. Therefore, accurate estimates of the mass accretion rate (\dot{M}_{acc}) and stellar parameters in different stages (early, i.e. Class I, and more evolved, i.e. Classical T-Tauri stars) of the star formation process have been provided for single stars and binaries. However, if we integrate \dot{M}_{acc} provided from the observations for the estimated timescales of YSOs, we found smaller masses than we measure. This means that the majority of the mass is set during the first stage of the highly embedded protostellar phase (Class 0), where planets start to form, or the accretion process proceeds in a non-steady framework. While we still know much less on accretion on Class 0, the non-steady accretion is proven by the eruptive YSOs, as FUors and EXors, which experience extremely strong bursts on short and long timescales. I will review recent results about accretion, focusing on open questions on early stages, as how the forming-star mass is related to the disk and envelope mass, and the relation between models and observations.



Eleonora Fiorellino

Curriculum Vitae

Current

- Oct 2020 – **Postdoctoral Fellowship**, Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Konkoly-Thege Miklós út 15-17, 1121 Budapest, Hungary ,
Jun 2023 Star formation group lead by Ágnes Kospal.
Position funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 716155 (SACCRED)

Education

- Nov 2017 – **PhD in Astronomy, Astrophysics & Space Science**, (1) La Sapienza (2) Università di Roma Tor Vergata (3) Istituto Nazionale di Astrofisica - Osservatorio Astronomico di Roma (4) Istituto Nazionale di Astrofisica - Istituto di Astrofisica e Planetologia Spaziali, Roma, ITA, and (5) European Southern Observatory, Garching bei München, Germany,
Dec 2020 Thesis: Star formation: from the prestellar core phase to the circumstellar disks.
Supervisors: Dr. Brunella Nisini, Dr. Davide Elia, Dr. Suzanne Ramsay and Dr. Carlo F. Manara.
- Oct 2014 – **Master Degree in Astronomy and Astrophysics**, La Sapienza, University of Rome
Sep 2017 Rome, Italy,
Thesis: The Core Mass Function of the Serpens star-forming region derived with Herschel data.
Supervisors: Prof. Marco De Petris & Dr. Stefano Pezzuto
- Oct 2010 – **Bachelor Degree in Physics and Astrophysics**, La Sapienza, University of Rome,
Sep 2014 Italy,
Thesis: Gravitational Waves Effects on Cosmic Microwave Background and BICEP2 results, Supervisor: Prof. Francesco Piacentini.

First name publications

The relation between the mass accretion rate and the disk mass in Class I young stars, *E. Fiorellino, L. Tyoniech, B. Nisini, S. Antonucci*, A&A, in prep..

Investigating a new eruptive YSO from Gaia alerts program, *E. Fiorellino, T. Giannini, S. Antonucci, Á. Kospal, B. Nisini, P. Ábrám, M. Siwak, S. Park, Z. Nagy, F. Cruz*, ApJ, in prep..

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- 2022 **The accretion variability of the WX Cha binary system**, *E. Fiorellino, G. Zsidi, Á. Kospal, P. Ábrám, and C. Manara*, ApJ, to be submitted.
- 2021 **The main accretor in the DQ Yau binary system**, *E. Fiorellino, S. Park, Á. Kospal, and P. Ábrám*, ApJ, accepted.
- 2021 **KMOS study of the mass accretion rate from Class I to Class II in NGC1333**, *E. Fiorellino, C. Manara, B. Nisini, S. Ramsay, S. Antonucci, T. Giannini, K. Biazzo, J. Alcalà, and D. Fedele*, A&A, 650A, 43F.
- 2021 **The census of dense cores in the Serpens/Aquila region from the Herschel Gould Belt Survey**, *E. Fiorellino, D. Elia, P. André, A. Men'shchikov, S. Pezzuto, E. Schisano, M. Benedettini, V. Konyves, D. Arzoumanian, M. Benedettini, D. Ward-Thompson, A. Bracco, J. Di Francesco, S. Bontemps, J. Kirk, F. Motte, and S. Molinari*, MNRAS, 500, 4257–4276.

Co-author publications

- 2021 **The accretion variability of the VW Cha binary system**, *G. Zsidi, E. Fiorellino, Á. Kospal, P. Ábrám, and C. Manara*, ApJ, submitted.
- 2021 **Recurrent strong outbursts of an EXor-like young eruptive star Gaia20eae**, *Fernando Cruz-Saenz de Miera, Á. Kospal, P. Ábrahám, S. Park, Z. Nagy, M. Siwak, M. Kun, E. Fiorellino, Z. M. Szabo, S. Antonucci, B. Nisini, L. Szabados, L. Wyrzykowski, D. Garcia-Álvarez, M. Drózd, and W. Ogloza*, ApJ, accepted. 2021arXiv211204140C
- 2021 **The Hi-GAL compact source catalogue - II. The 360° catalogue of clump physical properties**, *Elia, Davide; Merello, M.; Molinari, S.; Schisano, E.; Zavagno, A; Russeil, D.; Mège, P; Martin, P.G.; Olmi, L; Pestalozzi, M.; Plume, R.; Ragan, S. E.; Benedettini, M; Eden, D.J.; Moore, T.J.T; Noriega-Crespo, A.; Paladini, R.; Palmeirim, P.; Pezzuto, S.; Pilbratt, G. L.; Rygl, K. L. J.; Schilke, P.; Strafella, F.; Traficante, A.; Baldeschi, A.; Bally, J.; Gioregio, A.M. di; **Fiorellino, E.**; Liu, S.J; Piazzo, L; Polychroni, D.*, MNRAS, 504, 2, 2742-2766.
- 2021 **PENELLOPE: The ESO data legacy program to complement the Hubble UV Legacy Library of Young Stars (ULLYSES). I. Survey presentation and accretion properties of Orion OB1 and σ -Orionis**, *Manara, C. F.; Frasca, A.; Venuti, L.; Siwak, M.; Herczeg, G. J.; Calvet, N.; Hernandez, J.; Tychoniec, Ł.; Gangi, M.; Alcalá, J. M.; Boffin, H. M. J.; Nisini, B.; Robberto, M.; Briceno, C.; Campbell-White, J.; Sicilia-Aguilar, A.; McGinnis, P.; Fedele, D.; Kóspál, Á.; Ábrahám, P. Alonso-Santiago, J.; Antonucci, S.; Arulanantham, N.; Bacciotti, F.; Banzatti, A.; Beccari, G.; Benisty, M.; Biazzo, K.; Bouvier, J.; Cabrit, S.; Caratti o Garatti, A.; Coffey, D.; Covino, E.; Dougados, C.; Eislöffel, J.; Ercolano, B.; Espaillat, C. C.; Erkal, J.; Facchini, S.; Fang, M.; **Fiorellino, E.**; Fischer, W. J.; France, K.; Gameiro, J. F.; Garcia Lopez, R.; Giannini, T.; Ginski, C.; Grankin, K.; Günther, H. M.; Hartmann, L.; Hillenbrand, L. A.; Hussain, G. A. J.; James, M. M.; Koutoulaki, M.; Lodato, G.; Maucó, K.; Mendigutía, I.; Mentel, R.; Miotello, A.; Oudmajer, R. D.; Rigliaco, E.; Rosotti, G. P.; Sanchis, E.; Schneider, P. C.; Spina, L.; Stelzer, B.; Testi, L.; Thanathibodee, T.; Vink, J. S.; Walter, F. M.; Williams, J. P.; Zsidi, G.*, A&A, 650, A196, 46.

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- 2021 **Mass segregation and sequential star formation in NGC 2264 revealed by Herschel**, Nony, T.; Robitaille, J. -F.; Motte, F.; Gonzalez, M.; Joncour, I.; Moraux, E.; Men'shchikov, A.; Didelon, P.; Louvet, F.; Buckner, A. S. M.; Schneider, N.; Lumsden, S. L.; Bontemps, S.; Pouteau, Y.; Cunningham, N.; **Fiorellino, E.**; Oudmaijer, R.; André, P.; Thomasson, B., A&A, 645A, 94N.
- 2021 **Physical properties of the ambient medium and of dense cores in the Perseus star-forming region derived from Herschel Gould Belt Survey observations**, S. Pezzuto, M. Benedettini, J. Di Francesco, S. Sadavoy, E. Schisano, G. Li Causi, Ph. André, D. Arzoumanian, J-Ph. Bernard, S. Bontemps, D. Elia, **E. Fiorellino**, J. M. Kirk, V. Könyves, B. Ladjelate, A. Men'shchikov, F. Motte, L. Piccotti, N. Scheider, L. SPinoglio, D. Ward-Thompson, and C. D. Wilson, A&A, 645A, 55P.
- 2020 **Herschel Gould Belt Survey Observations of Dense Cores in the Cepheus Flare Clouds**, J. Di Francesco, J. Keown, C. Fallscheer, P. André, B. Ladjelate, V. Könyves, A. Men'shchikov, S. Stephens-Whale, Q. Nguyen-Luong, P. Martin, S. Sadavoy, S. Pezzuto, **E. Fiorellino**, M. Benedettini, N. Schneider, S. Bontemps, D. Arzoumanian, P. Palmerim, J. Kirk, and D. Ward-Thompson, ApJ, 904, 172D.
- 2020 **The Herschel view of the dense core population in the Ophiuchus molecular cloud.**, Ladjelate, B; André, P; Könyves, V; Ward-Thompson, D; Men'shchikov, A; Bracco, A; Palmeirim, P; Roy, A; Shimajiri, Y; Kirk, J M.; Arzoumanian, D; Benedettini, M; Di Francesco, J; **Fiorellino, E**; Schneider, N; Pezzuto, F. Motte, and HGBS Team, A&A, 638, A74.
- 2017 **The Hi-GAL compact source catalogue - I. The physical properties of the clumps in the inner Galaxy ($-71.0 < l < 67.0$).**, Elia, Davide; Molinari, S.; Schisano, E.; Pestalozzi, M.; Pezzuto, S.; Merello, M.; Noriega-Crespo, A.; Moore, T. J. T.; Russeil, D.; Mottram, J. C.; Paladini, R.; Strafella, F.; Benedettini, M.; Bernard, J. P.; Di Giorgio, A.; Eden, D. J.; Fukui, Y.; Plume, R.; Bally, J.; Martin, P. G. Ragan, S. E.; Jaffa, S. E.; Motte, F.; Olmi, L.; Schneider, N.; Testi, L.; Wyrowski, F.; Zavagno, A.; Calzoletti, L.; Faustini, F.; Natoli, P.; Palmeirim, P.; Piacentini, F.; Piazzi, L.; Pilbratt, G. L.; Polychroni, D.; Baldeschi, A.; Beltrán, M. T.; Billot, N.; Cambrésy, L.; Cesaroni, R.; García-Lario, P.; Hoare, M. G.; Huang, M.; Joncas, G.; Liu, S. J.; Maiolo, B. M. T.; Marsh, K. A.; Maruccia, Y.; Mège, P.; Peretto, N.; Rygl, K. L. J.; Schilke, P.; Thompson, M. A.; Traficante, A.; Umana, G.; Veneziani, M.; Ward-Thompson, D.; Whitworth, A. P.; Arab, H.; Bandieramonte, M.; Becciani, U.; Brescia, M.; Buemi, C.; Bufano, F.; Butora, R.; Cavuoti, S.; Costa, A.; **Fiorellino, E.**; Hajnal, A.; Hayakawa, T.; Kacsuk, P.; Leto, P.; Li Causi, G.; Marchili, N.; Martinavarro-Armengol, S.; Mercurio, A.; Molinaro, M.; Riccio, G.; Sano, H.; Sciacca, E.; Tachihara, K.; Torii, K.; Trigilio, C.; Vitello, F.; Yamamoto, H., MNRAS, 471, 100.

Observing Experience

9-22 Sept 2018 **NEON Observing School**, OBSERVATORY OF ASIAGO, Asiago, Italy.

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3/7

Accepted Observing Proposals as PI

- 2021 LUCI-LBT: 9.09 hours. *Investigating accretion and ejection processes in Class I young stars*
- 2021 REM: 38.6 hours. *Time evolution of active phenomena in the prototypical young eruptive star EX Lup*
- 2021 TNG: 4.05 hours. *First observations of very early stage of FUor outburst*
- 2019 LUCI-LBT: 17.02 hours. *Evolution of disk accretion in young protostars: paving the way to JWST observations.*

Accepted Observing Proposals as Co-I

- 2021 LUCI-LBT: 23.8 hours. *Toward a coherent view of the eruptive accretion phenomenon*, Giannini et al.
- 2020 TNG-HARPS/GIANO: 54.6 hours. *GHOsT: GIARPS High-resolution Observations of T Tauri stars*, Antonucci et. al
- 2018 LUCI-LBT: 15.9 hours. *Evolution of disk accretion in young protostars: paving the way to JWST observations.*, Nisini et al.
- 2017 ESO KMOS-VLT: 8.5 hours. *Evolution of disk accretion and mass ejection in young protostars*, Nisini et al.

Conference Presentations and Posters

Invited Talks and Seminars

- 24 Mar 2020 "Tracing the mass accretion rate in the young population of the NGC1333 cluster", *Seminar at the Osservatorio Astronomico di Roma*, Monte Porzio Catone, Rome, Italy.
- 21 Jan 2020 "Tracing the mass accretion rate in the young population of the NGC1333 cluster". *Star & Planet Formation Seminar*, ESO Garching, Germany.
- 17-19 Sept 2019 "Star Formation: from prestellar cores to circumstellar disks", *Year-End Workshop of PhD program*, La Sapienza, Rome, Italy.
- 10 Apr 2019 "The census of dense cores in the Serpens region from the Herschel Gould Belt Survey", *Wine & Cheese Seminar*, ESO Garching, Germany.
- 24-26 Sept 2018 "Star Formation: from prestellar cores to circumstellar disks", *Year-End Workshop of PhD program*, Tor Vergata University of Rome, Rome, Italy.
- 5-6 Jun 2018 "The census of dense cores in the Serpens region from the Herschel Gould Belt Survey", *SAG3 f2f Meeting*, IAP, Paris, France.

Accepted Talks to Conferences

- 08-28 Nov 2021 A new EXor candidate: Gaia20eae. *12th Gaia Science Alerts and the First ORP Time-Domain Astronomy Workshop 2021*, FORTH, Crete, Greece.
- 24-28 Jun 2019 Evolution of the mass accretion rate in YSOs of the NGC1333 cluster. *EWASS: European Week of Astronomy & Space Science 2019*, Manufacture des tabacs, University of Lyon 3, Lyon, France.

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- 13-14 May 2019 The Herschel Gould Belt Survey first-generation paper of the Serpens region. *Herschel 10 years after launch: science and celebration*, ESA/ESAC, Madrid, Spain
- Posters**
- 18-21 Oct 2021 "Accretion on the eccentric binary system DQ Tau", Fiorellino et al. *Star Formation From Clouds to Discs - A Tribute to the Career of Lee Hartmann*, online.
- 02-06 Aug 2021 "The accretion variability in the young multiple system WX Cha", Fiorellino et al. *TESS Science Conference II*, online.
- 28 Jun - 2 Jul 2021 "Finding new eruptive young stars with Gaia: the Hungary+Italy collaboration", Fiorellino et al. *EAS 2021*, online.
- 02-06 Aug 2021 "Photometric and spectroscopic study of the mass accretion in the T Tauri system VW Cha", Zsidi et al. *TESS Science Conference II*, online.
- 02-04 Mar 2021 "KMOS study of the mass accretion rate from Class I to Class II in NGC1333", Fiorellino et al. *Cool Stars 20.5*, online.
- 10-14 Jun 2019 "The Herschel Gould Belt Survey first-generation paper of the Serpens region", Fiorellino et al. *Zooming on star formation*, Vouleftikon buinding, Nafplio, Greece.
- 07-10 Nov 2017 "A study of THT Cold Cores Population in the Star-Forming Region in Serpens", Fiorellino et al. *IV Workshop on Millimetric Astronomy in Italy*, Bologna, Italy.
- 05-09 Jun 2017 "A study of the cold cores population in the Serpens star-forming regions", Fiorellino et al. *Francesco's Legacy: Star Formation in Space and Time*, Florence, Italy.

Teaching

- 2017 **Assistant of Prof. Matteo Cirillo for Laboratory of Physics I**, for *Physics Bachelor students*, TOR VERGATA UNIVERSITY OF ROME, viale della Ricerca Scientifica, 1 - Rome - ITA.
The course consists in lectures and laboratory lessons about classical mechanics and thermodynamics. I was in charge during the practical lessons.
- 2016 **Assistant of Prof. Leonardo Gualtieri for General Physics I**, for *Natural Science Bachelor students*, LA SAPIENZA, Piazzale Aldo Moro, 5 - Rome - ITA.
The course consists in lectures and exercising lessons about classical mechanics, thermodynamics, electromagnetism and optics. I was in charge during the exercising lessons and sometimes also during lectures. I also evaluated written and oral exams.

Outreaching

- on-going **Sguardo sui cieli del Lazio**, *Outreaching project financed by Regione Lazio, to outreach astronomy to middle-schools teenagers in Lazio (Italy). My contribution is on the stars and planets formation part, and on the presence of women in STEM*, Lazio, ITA.
- 04-06 Nov 2021 **ENGAGE 2021 - Comunicazione e Divulgazione della Scienza: metodi e strategie di successo**, *Iniziativa condivisa di VIS, INAF, Università Ca' Foscari e M9-Museo del '900.*, Mestre, Venezia, ITA, attending with a scholarship.
- Dec 2020 - Jan 2021 **La formazione stellare e planetaria nell'infrarosso**, *A seminar in three lessons on 8th Dec, 15, Dec, and 12th Jan*, zoom, ITA, Come Scrivere Una Grande Storia.

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- 13 Feb 2020 **La formazione stellare e planetaria nell'infrarosso**, Liceo di Desio, Desio, Milan, ITA, ESO Ambassador Program.
- 9-13 Oct 2019 **Le F estival de l'Atmosph re**, Le Courbevoie, Paris, FRA, ESO Ambassador Program.
- 28 Sept 2018 **Notte Europea dei Ricercatori**, Osservatorio di Monte Porzio Catone, Rome, ITA.

Awards

- 04 -06 Nov 2021 Free-fee to attend the ENGAGE 2021 workshop
- 01 Feb 2019 - 31Jan 2020 ESO Studentship in Garching
- 2017 RadioNet Travel Grant - 500 

Computer skills

Operating Systems: Linux/Ubuntu, Mac OS, Windows.

Programming Languages: Python, IDL, C, Fortran

Word Processing: Latex, OpenOffice, Keynote, Microsoft Office, Overleaf

Astro Packages: IRAF, Astrolib, Astropy, pyFITS, HEALPix, DS9, ESO reflex, TOPCAT, CuTex, UniMap, GETSOURCES

Other Activities

- 2020 - now **Funder member of *Collettivo Sin Miedo***, Rome, Italy.
Voluntary association that collaborate with Centri Anti Violenza (CAV) in Rome, supporting women in their empowerment process.
- 2018 - 2020 **Funder member of *Lo Spazio di Marielle Franco***, Rome, Italy.
It is a voluntary association that deals with assisting victims of domestic abuse.
- 2017 - 2020 **Member of *Associazioni Dottorandi Italiani (ADI)***, Italy.
- 2019 Dec **Scientific Assistant for the ESO P105 Observing Programmes Committee**, *European Southern Observatory*, Garching, Germany.
- 2014 - 2015 **Student operator for the Students with handicap**, *La Sapienza*, Piazzale Aldo Moro, 5, Rome, Italy.
- 2014 - 2015 **Student operator for the Erasmus Program**, *La Sapienza*, Piazzale Aldo Moro, 5, Rome, Italy.
- 2014 - 2017 **Student Representative**, *Faculty of Natural, Physical and Mathematical Sciences - La Sapienza*, Rome, Italy.
- 2010 - 2014 **Student Representative**, *Department of Physics - La Sapienza*, Rome, Italy.

Languages

Italian **Mothertongue**

English **Fluent**

French **Advanced, C1 Level**

Saint Louis des Fran aises - Rome - 2010

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Interests & Hobbies

Singing and go to concerts; travelling; reading italian, french and english literature and drama; swimming; learning new languages and cultures; social equality and civil rights, in particular gender equality and LGBTQ+ pride.