209. A selection of journal plaudits

I WILL END this fourth year of my weekly essays on Gaia with some of the positive words that have appeared in the scientific literature about the mission.

I hope that all scientists involved, all who worked on Hipparcos and Gaia in ESA and industry, members of the Gaia Data Processing & Analysis Consortium, funding agencies, and members of ESA's advisory committees, will appreciate this wider perspective of the impact that Gaia is having across astronomy.

I will start with just a few comments on Gaia's predecessor, Hipparcos, which – crucially – established the foundations and principles of space astrometry.

HIPPARCOS

Hipparcos is the first time since Sputnik in 1957 that a major new development in space science has come from outside the United States
Freeman Dyson, *'Infinite In All Directions'*, 1988

The scientific impact of the Hipparcos mission is only now beginning to be felt. Perhaps the most inspiring aspect of this effort is the staggering degree of cooperation required
Janet Mattei, AAVSO (Sky & Telescope, July 1997)

Our Galactic star precinct has just been well mapped for the first time, ready for a century of searching stars for the promise of life. A terabit of data from the European Space Agency satellite Hipparcos underlies a magnificent list of over a hundred thousand star distances of unprecedented accuracy out to nearly five hundred light-years
Philip Morrison (Scientific American, February 1998)

Hipparcos was one of our most distinctive all-European missions. No other space agency has attempted anything like it Roger–Maurice Bonnet (Bern SPC, May 1999)

The bedrock of astronomy remains the compilation of what is out there… It is invidious to single out surveys which I find particularly impressive, but I make an exception for the Hipparcos astrometric satellite
Malcolm Longair (Millennium Essay, PASP, 2001)

GAIA IN GENERAL

Galactic astrophysics is currently in a similar phase as geography was in the 15th century: large parts of the Earth were unknown to contemporary scientists, and only crude maps of most of the known parts of the Earth existed… In this context, the astrometric ESA mission Gaia represents a major leap in our understanding of the Milky Way's stellar content Anders et al. (2019)

It's a fundamental rewriting of how we do positional astronomy Marc Buie, Science Magazine (24 Nov 2020)

The stunning revolution being operated by Gaia has often been mentioned during the conference and examples have been shown in a number of talks
Clementini et al. (2020)

Gaia Early Data Release 3 opens a new chapter in the measurement of parallaxes Soltis et al. (2021)

The next generation will never know the struggle to determine a distance or a spectral type thanks to you and the Gaia team Chas Beichman (priv. comm., July 2022)

The ESA Gaia space mission is one of the most successful projects in the history of astronomy
Cantat-Gaudin (2022)

Gaia provides a revolutionary step forward in our understanding of the true locations of stars in the Milky Way
Davenport et al. (2022)

Gaia has revolutionised astrometry Munn et al. (2022)

Among surveys, Gaia holds a unique place because it provides high precision astrometric, photometric, and spectroscopic data for an unprecedented number of sources
Tsantaki et al. (2022)

Gaia has revolutionised astronomy with its high-precision astrometry Wilson (2023)

One of the most remarkable space science missions that most people have never heard of is Gaia: a mission by the European Space Agency to map out the three-dimensional positions and motions of more stars in the galaxy than ever before
Ethan Siegel, *'Ask Ethan'*, 11 August 2023

Gaia Data Release 3 provides data on positions, parallaxes, and proper motions for a staggering 1.46 billion celestial objects Bisht et al. (2024)

We are now deep into the era of Gaia – the most ambitious Galactic science mission of all time
Deason & Belokurov (2024)

The staggering Gaia DR3 released low-resolution spectra for 220 million stars to G = 17.6 mag, and medium-resolution spectra for one million stars to G = 13 mag
Viswanathan et al. (2024)

Stellar structure and evolution

In the Gaia era, stellar evolution modellers have the daunting task of explaining an increasing number of precisely determined features in the colour–magnitude diagram Davenport & Covey (2018)

Gaia is opening an important new window in the study of the interstellar medium Großschedl et al. (2018)

Another ongoing, and perhaps more important revolution in the white dwarf field is the Gaia mission, which will probably discover about 400 000 white dwarfs when the mission is completed Bergeron et al. (2019)

We address two specific fields where Gaia is really astonishing: the detailed monitoring of stellar populations in different evolutionary phases, and the distance scale
Clementini et al. (2020)

The exquisite quality of the data produced by Gaia is revolutionising our knowledge of the Milky Way, allowing us to resolve and characterise its stellar populations to an unprecedented level of detail Marchetti et al. (2022)

Great progress has been made in [the structure of giant molecular clouds] with the arrival of the Gaia mission
Dharmawardena et al. (2023)

Gaia DR3 contains a stellar activity index derived from the Ca II infra-red triplet for some 2 million stars in the Galaxy. This represents a 'gold mine' for studies on stellar magnetic activity and mass accretion in the solar vicinity
Lanzafame et al. (2023)

Since 2018, data from the Gaia mission are revealing previously unseen and often unexpected 3D distributions of gas, dust, and young stars in the solar neighbourhood
Zucker et al. (2023)

Gaia Data Release 3 represents an unparalleled revolution in Galactic archaeology, providing us with radial velocities and chemical abundances for million of stars, overcoming the spatial biases suffered by spectroscopic surveys from the ground Spitoni (2023)

Gaia has revolutionised the calibration of Leavitt's Law [for Cepheids] in the Milky Way based on trigonometric parallaxes Anderson (2024a)

The advent of Gaia has made it possible to construct ever-more accurate 3D dust-based distances to molecular clouds Cahlon et al. (2024)

This review highlights the role of the Gaia space mission in transforming white dwarf research
Tremblay et al. (2024)

Star clusters

This study shows the incredible wealth of data provided by Gaia for the study of young stellar clusters
Beccari et al. (2018)

Gaia has opened a new window into the internal kinematics of young star clusters at the sub-km s^{-1} level
Kuhn et al. (2019)

The census of open clusters in the Milky Way is in a never-before seen state of flux. Recent works have reported hundreds of new open clusters thanks to the incredible astrometric quality of the Gaia satellite
Kuhn et al. (2019)

The Gaia data have unlocked a deluge of new results related to many astronomical topics, and transformed our ability to study star clusters and stellar structures in the Milky Way Cantat-Gaudin (2022)

Our knowledge of the memberships of open star clusters provides the foundation for a wide range of topics in stellar astrophysics – and Gaia has revolutionised the study of clusters Kastner (2023)

The Gaia revolution has also allowed for membership studies of open clusters on the Galactic scale including thousands of clusters Fritzewski et al. (2023)

It is probably safe to assume that no single instrument will have, in the near future, a transformative impact comparable to Gaia
Cantat-Gaudin & Casamiquela (2024)

The excellent photometry and distances from Gaia have provided systematic isochronal ages for hundreds of previously known clusters and associations and thousands of Galactic stellar ensembles that have been recently identified Miret-Roig et al. (2024)

Star multiplicity

Gaia has revolutionised our understanding of stellar multiples, stellar associations, and the 3D structure of the solar neighbourhood Cunningham et al. (2020)

The space astrometry mission Gaia has revolutionised wide binary research Hwang et al. (2022)

Gaia has revolutionised the census of solar neighbourhood by revealing wide pairs of stars with an unprecedented completeness Tokovinin (2023)

Much of the progress in the last decade has been enabled by the Gaia mission. The data probe a wider range of binary separations and mass ratios than most previous surveys, enabling both an improved binary population census and discovery of rare objects El-Badry (2024)

The discovery of co-moving wide binary candidates in the Milky Way has significantly increased based on high-precision parallax and proper motion solutions for a vast number of stars provided by Gaia Lim et al. (2024)

Photometry and Variability

Gaia is a unique transient survey, detecting supernovae, tidal disruption events, cataclysmic variables, and microlensing events Wyrzykowski et al. (2018)

In principle and in perspective, Gaia synthetic photometry may constitute a true revolution in optical photometry Montegriffo et al. (2023)

Gaia is now one of the most successful and leading transient space missions Kvernadze et al. (2023)

Variable star research is about to undergo a revolution driven by large time-resolved imaging surveys such as ESA's Gaia mission Anderson (2024b)

Galaxy structure and dynamics

The field of Milky Way dynamics is reaching an incredibly exciting time, as the successful launch and operation of ESA's Gaia satellite means that we have access to proper motions and parallaxes for a billion stars. This represents an increase of four orders of magnitude over the number of stars with known parallaxes from Gaia's predecessor, Hipparcos. This information will revolutionise how we understand our own Galaxy, and by extension, the Universe as a whole McMillan (2017)

Gaia stellar measurements are currently revolutionising our knowledge of the evolutionary history of the Milky Way Lallement et al. (2019)

The Gaia Early Data Release 3 direct measurement of the acceleration of the solar system within the Milky Way galaxy from the apparent proper motion pattern of distant quasars that it induces is a revolutionary moment for Galactic astrophysics Bovy (2020a)

Since its first data release in 2016 and especially since its recent second data release in 2018, Gaia has impacted nearly every field in astrophysics. Nowhere is this more the case than in the study of Milky Way dynamics Bovy (2020b)

The history and present evolutionary state of the Milky Way are currently being deciphered at all spatial scales, boosted by the remarkable Gaia measurements Ivanova et al. (2021)

The recent Gaia EDR3 opens a new chapter in the measurement of parallaxes, placing the precise and accurate determination of the distances to nearby Galactic globular clusters within reach Soltis et al. (2021)

Gaia has revolutionised Galactic dynamics by providing positions, parallaxes and proper motions with unparalleled precision for a large number of Milky Way stars Angus et al. (2022)

Gaia has revolutionised the study of Galactic archaeology by measuring the stellar kinematics of stars in the solar neighbourhood with an unprecedented precision Ghosh et al. (2022)

Gaia's unique capability in stellar measuring proper motion and vast dataset is revolutionising our understanding of Milky Way structure Buckley et al. (2023)

Since the first data release, Gaia has played a major part in revealing the kinematics of our Galaxy Wang et al. (2023)

Gaia has provided revolutionary observational data that have uncovered detailed kinematical features of stars in the Milky Way Funakoshi et al. (2024)

The Gaia mission has revolutionised our view of the Milky Way and its satellite citizens… It has changed our view on how the Milky Way assembled, it has changed how we model the Galaxy, and it has opened our eyes to new research directions and explorations Deason & Belokurov (2024)

The Gaia Data Releases, DR1 and DR2, changed our entire perspective of visualising the Galaxy and its neighbourhood Dhanush et al. (2024)

In the age of Gaia, the local stellar velocity distribution is now known with exquisite precision
Hopkins et al. (2024)

Stellar streams

Gaia has opened up a spectacular vista onto the Milky Way's halo, revealing a lacework of criss-crossing ancient and ongoing accretions that testify to the violent formation history of our Galactic home Ibata et al. (2021)

The second data release of Gaia expanded our ability to make [6-dimensional phase-space] maps by several orders of magnitude, by measuring proper motions for more than a billion Milky Way stars. This phenomenal wealth of data has already facilitated the discovery of many new streams Reino et al. (2021)

Our view of the variety of stellar structures pervading the local Milky Way has been transformed by the application of clustering algorithms to the Gaia catalogue
Andrews et al. (2022)

The high-precision astrometric survey Gaia has revolutionised [the field of stellar streams] and allowed for measurements of the proper motion of faint stream stars for the first time Ferguson et al. (2022)

The revolution brought about by the deep astrometric (and photometric) survey of the Gaia satellite is truly staggering. With each new data release, the Milky Way's phase space is revealed in a wealth of ever more complex and intricate detail Martin et al. (2022)

This analysis [of the proto-Milky Way] reflects the astounding information content of the Gaia Data Release 3, particularly the XP spectra Rix et al. (2022)

The field of stellar streams is currently in a golden era. It has increasingly grown and all but exploded in the last decade, thanks to deep wide-area photometric surveys and, more recently, to the amazing possibilities opened by the all-sky astrometric information provided by the Gaia mission since its Second Data Release Mateu (2023)

The Gaia mission has brought fundamental changes to our view of stellar streams in the Milky Way
Bonaca & Price-Whelan (2025)

The identification by Helmi et al. (1999) of a handful of stars belonging to a stellar stream passing through the solar neighbourhood is a good example of the type of archaeological experiment that had appeared trailblazing and challenging before Gaia, but has been made effortless and almost mundane thanks to Gaia today
Deason & Belokurov (2024)

Solar system

The results from ESA's Gaia mission, an unparalleled catalogue of stellar position, distances, and kinematic states that have, in turn, unlocked the door to widespread studies of the outer solar system Buie (2022)

The precision of the Gaia catalogues has marked the beginning of a new era in predicting stellar occultation
Souami et al. (2022)

There are so many revolutionary advances that it is difficult to pinpoint a single most significant advance
Karri Muinonen, Space.com, 28 July 2022

The release of Gaia catalogue is revolutionary to the astronomy of solar system objects Guo et al. (2023)

Exoplanets

Thanks to Gaia, uncertainties in stellar radii are no longer the limiting uncertainties in determining planetary radii for the majority of Kepler planets
Petigura (2020)

Gaia is revolutionary for almost every field in astrophysics, and exoplanets is no exception
Sanderson et al. (2022)

The Gaia space mission is impacting astronomy in many significant ways… Exoplanet science has greatly benefited from the unprecedented accuracy of the stellar parameters obtained from Gaia Swastik et al. (2023)

Telescope operations

Many of our new observatory operational and scientific developments have directly benefited from Gaia data releases in ways that were simply not possible before. Its high-precision astrometric and spectroscopic data has been transformative for both our operations and our science.
Stephen Potter, SAAO (priv. comm., December 2024)

Gaia has been transformative in various ways. It has provided, for the first time, a reliable and dense set of guide stars for wide-field spectroscopy across the entire sky, especially for the southern hemisphere. Before Gaia, many many hours were spent cobbling together various sources of guide stars, ensuring they were on the same system, estimating magnitudes, etc. This instantly became a completely solved problem when Gaia data was available
Mike Blanton, SDSS (priv. comm., December 2024)