The academic I meant to be

Rossi, E.M.

Prof.dr. Elena M. Rossi

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Universiteit Leiden

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The academic I meant to Be

Inaugural Lecture by

Prof.dr. Elena M. Rossi

on the acceptance of her position as professor

Theoretical astrophysics

at Leiden University

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Universiteit Leiden

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Dear colleagues, friends and family,

Each of you has played an integral role in the journey that has led me to this moment. Whether your contribution has been long or brief, each of you has helped shape the academic path I've traveled, and for that, I am deeply grateful.

I truly appreciate the time you've taken to join me today --in person or online-- as I reflect on the professional experiences that have brought me to the honour of becoming a full professor at the Leiden Observatory.

In the course of this talk, I'll take you through a selection of key moments from my career, examining the opportunities I've had, the challenges I've faced, and how each of these has shaped me as a scientist and as an individual. Along the way, I'll also highlight some of the key moments in my scientific research, sharing the excitement and fulfillment that continues to drive me in my work.

Unfortunately, given the limited time, I won't be able to mention everyone who has played an important role in my journey. However, please know that each and every one of you—whether directly or indirectly—has made a difference, and I carry your support with me in all that I do.

Monza

My path to where I am today has not been a straight line. It has involved a search for my identity, a quest for personal satisfaction, and an unrelenting drive for self-improvement. The Netherlands is a remarkable country, more effective than Italy in many aspects. However, the Dutch school system, would not have suited me as a child: here, children's academic futures are decided as early as age 11—at a time when initial conditions and personal insecurities can play a significant role in shaping a child's school performance. Had I been raised in the Netherlands, I might not be here today. In Italy, however, we have the freedom to choose and change high schools without penalty, and all paths lead to university, if we so choose. This allowed me to mature before making important and definitive decisions. I believe that this flexibility in the Italian educational system has played a crucial role in fostering a higher representation of women and minorities in academic STEM fields, compared to countries like the Netherlands, where professional paths are set early in life. Of this, Leiden University, The Netherlands and the academic world at large have greatly benefited.

At the end of primary school in Monza, where I grew up, circumstances led me to believe that I wasn't strong enough in mathematics to pursue a scientific high school. I thought my creativity would be better expressed in an art school. After a year and a half, though, I realized that the art school wasn't challenging enough for me. I craved more—more knowledge, more intellectual stimulation—and I asked my parents to transfer me to an elite school specialized in the humanities, as, I still tried to stay away from mathematics as much as possible.

This school, College Bianconi, turned out to be one of the best decisions I could have made. It was incredibly demanding, and through real effort, I learned not only how to study and organize my time but also how to persevere. The school's teaching method helped me develop an ability that would become central to my later work as an astrophysicist: seeing meaningful connections across diverse fields and using that synergy to deepen my understanding of complex topics.

At College Bianconi, I had one hour of mathematics and two hours of physics per week, while the humanities subjects such as philosophy, history, and literature took up most of my schedule. My maths and physics teacher was a remarkable woman who was simultaneously pursuing her Ph.D. in mathematics while teaching us and raising three children. She saw qualities in me that I couldn't see myself, and her recognition of my potential motivated me to work harder. As a result, I began to earn high grades in not just the humanities but also in mathematics and physics. I completed my high school with top marks and an undeniable desire to continue studying physics at university.

Milano

However, when I told this to my parents --who had typically supported all my choices throughout their lives -- their very first reaction this time was, 'Oh no! It's a mistake. You'll drop out or change topic!' I realised then that my father didn't expect me to go to university, and if I really wanted to, it had to be in humanities. Well, that wasn't exactly the most encouraging start to my university career. For four years, I felt as though I had something to prove, and the possibility of failure felt very real initially. I entered university without knowing what differential equations were, but the soft skills I learnt in high school—such as an effective method of study, time management, resilience, and focus—served me well. These qualities, along with a deep passion for physics, allowed me to bridge the knowledge gap between myself and my more prepared peers within just one year.

I can't emphasize enough how crucial personal qualities and soft skills are to becoming a successful student and researcher, as much as having a solid foundation in hard skills or prior knowledge in a field. This philosophy is something I carry with me today, especially when selecting PhD students. One-third of my PhD students have backgrounds outside of astronomy or even physics, and 80% of them entered their research without prior knowledge of the specific topic they would investigate, and they all were/are successful.

Coming back on my university years, I chose to specialize in astrophysics in my fourth year. What fascinated me about this field was the extreme physics of the universe, phenomena that cannot be recreated in laboratories on Earth. Moreover, in astronomy, all our observations are indirect. To understand an astronomical object, we must use our imagination and creativity to extract information from the light or other signals it emits, which may have traveled millions or even billions of years to reach us. After 10 years from finishing my primary school I had finally found out how to use my creativity at best: not by drawing, but by imagining the Cosmos.

Cambridge

In my final year at university, I discovered gamma-ray bursts (GRBs) thanks to another amazing and enthusiastic teacher who crossed my path: Gabriele Ghisellini, from the Observatory of Merate, Italy. GRBs are the most luminous objects in the universe— jets of energy traveling at speeds close to the speed of light. I was told that if I wanted to work on this cutting-edge research, the best place to be was Cambridge, UK, and specifically, to work with Prof. Martin Rees. So, I made a bold decision: I turned down two PhD offers in Italy, packed my bags, and moved to Cambridge without a contract, hoping to apply for a PhD in the upcoming cycle. I lived with friends and worked full-time as a babysitter for kids of astronomers, some of whom are in the audience, as well as other academics from Cambridge. It was certainly a risk—there were no guarantees that I would be accepted—but I immersed myself in colloquia, read extensively, and prepared to engage with Martin and begin working with him.

The uncertainty remained high, especially when an oral exam was conducted to assess my English proficiency. While I had studied English more than the average Italian student at school, it's fair to say that that first year abroad, I could catch only about 50% of what native English speakers were saying to me! But somehow, I made it through. I vividly remember the moment when I jumped up and down in Max Pettini's office after he told me I had secured a PhD position and could begin at the Institute of Astronomy in September!

So, I started working with Martin on GRBs, with the freedom to explore the literature and bring him a project of my own interest. I am grateful for the independence and trust he placed in me. My first paper focused on the energy structure of a GRB jet, proposing that the energy per unit solid angle decreases as you move further from the jet's spine—something we call the "structured jet." We specifically proposed this idea for GRBs associated with the collapse of a massive star core that would produce a supernovae and a jet, and it is fair to say that the jury is still out for this class of objects. However, in 2018, the detection of a GRB following the merger of two neutron stars provided clear evidence that the jet followed a "structured" pattern. Martin's insight, which he shared with me early on, remains invaluable: "If your physical model is sound within the boundaries of the problem, it doesn't mean it has to play out exactly where you expect it, but it shows that it can happen, and probably does, somewhere else in the universe. So, don't become too attached to your idea. Your work has value beyond that, and someone in the future will find the correct place for it if you can't." That paper remains today highly relevant, and it is still my most cited one. I try to pass on Martin's teaching to my own students now.

Cambridge was an amazing experience, one I would do again in a heartbeat, for science, but also for the friends I made there. But it was also incredibly challenging. The world of theorists, especially in the field of GRBs, was dominated by strong personalities, where the competition often revolved around who is the 'smartest'. The GRB field itself was highly competitive, aggressive, and at times, unfair. I still remember senior figures at conferences standing up during Q&A sessions, shouting at each other, "You're wrong! You're wrong! I don't have the time to explain why, but you're completely wrong!" This aggression sometimes extended to referee reports with personal attacks. One of the most difficult moments occurred when a senior scientist tried to take my idea for the "structured jet" after I presented it as a poster at a GRB conference. My advisor, Martin, fixed the situation. From that experience, Martin taught me an important lesson on how a supervisor should behave—standing by their students, especially in the face of unfairness.

To be honest, I didn't openly question this negative and inappropriate behavior at first, as it seemed to be accepted by many. But I knew that I didn't want to behave that way, and I took a step back, vowing to never let such conduct define me or my work.

Boulder

It probably won't surprise you, then, to hear that after being awarded a NASA Chandra Fellowship at the University of Colorado in late 2005, I shifted my research focus to Massive Black Holes (MBHs). Mitch Begelman and Phil Armitage at CU Boulder, who had done pioneering work in this field, Mitch was also Martin's student, passed on their passion for the subject to me.

But before continuing, let me share another pivotal encounter that shaped my future: meeting CU Boulder faculty member Peter Bender. One day, Peter asked me, "Have you heard of a mission to detect gravitational waves from space? It could be a unique way to detect massive black holes across the Universe." This was the first time I heard about what is now called the Laser Interferometer Space Antenna (LISA). Later I learnt that Peter had proposed the mission back in the 1970s. To give you a historical context, gravitational waves had not been directly detected yet and only Earth-based detectors were being built in the hope of performing such a discovery. However, Peter's vision and enthusiasm sparked my desire to join this groundbreaking effort, despite or perhaps because of the high-risk-high-gain nature of the mission. And, as I'll explain later, that's exactly what happened.

Let's return to MBHs. These black holes, which are millions to billions times the mass of our Sun, are found at the centres of most galaxies. A central question is: When and how do these enormous black holes form? We know that classical stars, of at least 15-20 times the solar mass, leave behind black holes of similar or smaller masses at the end of their lives: we call them "stellar mass black holes". However, we don't know of any classical star massive enough that could theoretically leave behind a MBH at the end of its life.

Between 2008 and 2017, building on a paper Mitch published with Martin Rees and Marta Volonteri, I focused on a model where, as gas collapses to create a galaxy, much of it is funnelled toward the centre, creating what we called a 'quasi-star'. Unlike a regular star, which is held up by nuclear energy, a quasi-star is a gas ball weighing about a million solar masses, with a small black hole of stellar origin at its core. This black hole accretes material, injecting energy into the gas and preventing collapse. The gas shines at the maximum theoretically allowed for the entire envelope, and at "red" frequencies, due to its large radius of about the distance between the Earth and the Sun.

By accreting mass from its gigantic envelope, the black hole can gain a significant mass in less than a million years. Once the envelope disperses, the newly formed MBH is revealed. It was a fascinating challenge to understand the physical conditions under which quasi-stars could form and their possible observational signatures in the James Webb Space Telescope (JWST), which we anticipated launching soon.

As many astronomers know, the JWST launch was delayed until 2021. Yet, among its discoveries, it found about 350 "little red dots", which are compact "red" sources, of which some are claimed to be quasi-stars! More data is needed to confirm this, but even only the sheer possibility that an object whose physical structured I envisioned so long ago could actually exist out there is incredibly thrilling!

Jerusalem

After Boulder, I took a postdoctoral position at the Hebrew University in Jerusalem—an enriching chapter in my life, both professionally and personally. I still have many dear friends and colleagues there. I had the privilege of working with brilliant researchers, spending countless hours at the blackboard, tackling fascinating problems. Like my time in the U.S. and Cambridge, I was encouraged to focus on research that intrigued me and pushed boundaries. In those years, the pursuit of grants was never my drive—our goal was always knowledge for discovery's sake.

While at Hebrew University, I continued studying quasi-stars with Nir Shaviv. Engaging with colleagues like Re'em Sari and Shiho Kobayashi, I became increasingly fascinated by galactic nuclear phenomena, particularly the behaviour of stars and stellar-mass black holes near MBHs. The dynamics of these interactions intrigued me, especially in using their observable consequences to discover and measure the properties of quiescent MBHs. These black holes, which have little surrounding gas, remain faint and difficult to observe unless very close by. A prime example is the quiescent MBH at the center of our galaxy, Sagittarius A* (Sgr A*). Quiescent MBHs are the majority in the universe, and understanding their mass and origin is crucial to solve the mystery of MBH origin in general.

In Jerusalem, I began working on two key topics, leading to my receiving the ERC Consolidator Grant in 2020 and the VICI Grant in 2022. So, my curiosity-driven science did eventually acquire monetary value!

The first topic is \textbf{hypervelocity stars}. When a binary star gets too close to a MBH, gravitational forces can split it, with one star remaining in orbit while the other is ejected at high speed—sometimes thousands of kilometers per second. These stars, called hypervelocity stars, are found in the halo, a sparsely populated region outside our Galaxy's disc, making them stand out. However, these events are extremely rare; hypervelocity stars make up just 1 in every ten to hundreds of millions of stars in the halo. To find them, we need a big "net": \textbf{Gaia}, the largest star survey ever conducted, with data on over 2 billion stars. Building on the work started in Jerusalem, my collaborators, students, and I developed models in Leiden to simulate the ejection of these stars from the Galactic centre. We use Gaia data to track them, gaining deeper insights into the origin of stars in our galactic centre and providing the first observational constraints on the rate of binary stars in these extreme orbits. This is key to understanding phenomena like Extreme Mass Ratio Inspirals, gravitational wave sources detectable by LISA, and the newly discovered Quasi-Periodic Eruptions in X-rays.

Many of our key recent results come from my excellent students Fraser Evens, Sill Verberne, and Tommaso Marchetti, in collaboration with Anthony Brown and Koen Kuijken in Leiden, and Sergey Koposov in Edinburgh. Currently, Bianca Sersante and Manuel Cavieres-Carrera, alongside postdoc Zephyr Penoyre, are leading the work. The energy and synergy within the group are incredible, driving forward our understanding of galactic nuclei and pioneering new approaches to data mining.

Another fate for a star too close to a MBH is being torn apart by its gravitational forces. This is a \textbf{Tidal Disruption Event}, a powerful way to detect quiescent MBH in distant galaxies. My goal is to understand how the light from these disruptions is produced and use it to measure the black holes' properties. My first paper on this topic came out of a visit from my friend and collaborator Giuseppe Lodato. Together, we analytically determined the observational appearance of such a disruption across different frequency bands, assuming that half of mass of the disrupted star would form an accretion disc around the black hole. Our paper is still a reference for observers trying to detect such discs in the early stages of the disruption of the star.

Shortly after finalizing this paper, I moved to Leiden Observatory for a tenure-track position in 2011.

Leiden
In the same year, Sjoert van Velzen—who was a PhD student in Nijmegen at the time and is now a friend and colleague of mine at Leiden—observed the optical emission in two tidal disruption events for the first time. His observations showed that the model I developed with Giuseppe Lodato couldn't explain the early-time emission in the optical band. That was a turning point for me. I realized that to truly capture the complexity of stellar disruptions and predict their emission properties reliably, we would need to turn to computer simulations and understand whether an accretion disc can actually form.

This became the focus of the thesis of my first PhD student, Clement Bonnerot, co-supervised by Giuseppe. Clement is now a faculty member at Birmingham University. Clement's simulations were pioneering, allowing us to begin to understand what physical conditions were needed to form an accretion disc. But even those simulations had limitations due to the approximations we had to make to reduce computational time. Simulating tidal disruption events is incredibly challenging because of their multiscale nature, where we need to resolve both the tiny size of the star and the massive size of a galactic nucleus at the same time.
To tackle this, I teamed up with astronomer and code developer Elad Steinberg, and collaborator Nick Stone, who had made significant progress using a computational technique designed to address this exact multiscale problem in tidal disruption events. By leveraging this new tool and analyzing unprecedented simulations, my PhD students Paola Martire and Konstantinos Kilmetis have made tremendous strides. Their work is the topic of their thesis and has put them at the forefront of unraveling the mystery behind the early flashes of light in tidal disruption events. Finally, with PhD student Anna Balaudo (now post-doc at University of Portsmouth), we came back to the original science goal, and have explored how current and future observations of tidal disruption events can differentiate between different formation scenarios of MBHs.

Since the start in Leiden in 2011, I've had to adapt to a wide range of new responsibilities. In my first 10 years, I taught seven different courses, something I had to learn quickly. I also started assigning research projects and supervising multiple students at the same time, on average 5 per year, and now 10 students! for a grand total of over 60 master and bachelor projects and 9 PhD students. On top of that, I had to learn how to write research proposals—a skill I hadn't developed before coming to Leiden. Finally, I took on various duties within the institute, including serving on hiring committees. All of these new responsibilities drastically reduced the time I could dedicate to my own research, which had been my only focus up until then. I cannot but think that I was hired for a job I hadn't been trained for!

While this shift was challenging, I truly enjoyed the learning process. It took about three years to return to conducting research at a competitive level—at least at a level that felt satisfying to me. This return to research accelerated in 2013, when I hired Clement. Looking back, I realize I was inexperienced enough at the time not to negotiate any startup funding when I first arrived in 2011, which would have allowed me to start already with a research group.

This experience has shaped my approach to mentoring students and postdocs. I'm committed to equipping them with a broader skill set than just research. I train them to be effective supervisors and teaching assistants, encouraging them to communicate complex physics concepts clearly and methodically—an essential skill whether they stay in academia or move into industry. I also involve them actively in the recruitment process for new members of our group, giving them insight into how we build and grow our team. I think strategically about their careers: What projects, collaborations, conferences, and experiences will help them succeed? Most importantly, I strive to pass on the enthusiasm and passion for our work that has always motivated me throughout my career. This job is best done with a sense of purpose and a strong sense of community, and I want my team to share in that joy.

One day in 2011, during my second year at Leiden, I was sitting at my desk, trying to figure out why my first ERC proposal had been rejected and judged "incremental." I was cursing every member of the ERC committee in alphabetical order when I heard a voice from the open door: "Ciao Elena, do you have a minute?" My immediate thought was, "No! It's a bad day!" But when I looked up, I saw several PhD students and postdocs—almost all female—standing at the door, looking at me expectantly. Without thinking, I said, "Oh yes, of course, come in!"
They wanted to discuss their experiences at the institute and propose changes. The problem was, they didn't know whom to talk to, so they decided that I was the most approachable professor. That moment made me realize, for the first time, that it mattered—really mattered—that I was one of only two female faculty members in a department of over 20 professors. The other female astronomer was already a full professor and very engaged outside the department, so, for all practical purposes, until 2015, I was often the only woman in the room.
That day marked the beginning of many spontaneous and lively meetings--which I chaired until 2020-- that would eventually evolve into our current three different official committees: DEI (Diversity, Equity and Inclusion), Well-being, and Green Committees. To give you some perspective, back in 2011, there was none of the supportive infrastructure we now take for granted in our department: no surveys, no workshops, no DEI or social committees, no local confidential support formally in place and no recycling programs. All of these things were a direct result of that first meeting in 2011.

Here are three examples: I still remember, together with postdoc Alessandra Candian (now faculty at UvA), asking Eric Deul for just some recycling bins next to the printers. We got them, of course (Erik has always been supportive!), they were carton boxes, and in the first period, we were emptying them ourselves to recyling the bins at the ground floor of the Oort building. Second, we pushed to abandon the plastic cups for the coffee --maybe some of you still remember them -- and use mugs instead, supporting our requests with a study on the monetary and environmental impact of that choice: and that's why we have got the mugs now! Finally, in 2014, we were thinking about supporting mothers returning to work after their maternity leaves and one day with PhD student Anna Miotello, (now staff at ESO), we went looking for a nursing room in both of the buildings of the Observatory—and found none. This was especially crucial for students and postdocs who didn't have their own offices. So, we went to the faculty office, where we were met with the response, "Err...nursing room...yes, I have the keys somewhere..." The receptionist at the Gorleus Building led us to the basement and opened a door—only to reveal boxes, dust, and no windows. "It's been used as storage," he said, stating the obvious.

We looked at each other and decided to set up a nursing room ourselves. With the help of the Faculty of Science and Evelijn Gerstel, our institute manager at the time, we created the first-ever nursing room in the Observatory building—well-equipped and even decorated. And while writing this speech, out of curiosity, I visited the nursing room in our new building. Thankfully, it's \textit{not} a storage room!

This brings me to another pivotal experience at Leiden, one where I truly understood what it meant to be a "first of its kind." During my probation period, I became pregnant with Alma in 2013. I went to management to share the news and to ask, "What is the Observatory's policy for supporting my PhD students while I'm away? How will my courses and committee duties be covered? And what happens when I return to work with a little baby?" The answer, of course, was: "There is no policy—no academic staff member has ever given birth here." Then I was asked, "Well, what do you think you need?" And I honestly replied, "How should I know? I've never been neither pregnant or on a tenure track before. I have no idea how this is going to work!" It wasn't an easy process to navigate, and both inexperience and uncertainty led to some missteps, including an overestimation of what I could handle when I returned from maternity leave. But throughout, I felt the genuine support of most of my colleagues --I especially remember Alessandro Patruno helping with my teaching duties--and the management, especially Evelijn, who truly wanted to help me succeed. Though I emerged from my post-partum teaching semester sleep-deprived, I was definitely wiser.

This experience with my first pregnancy made my second, with Sofia, two years later, much smoother. And I like to think, or at least hope, it helped pave the way for my female colleagues who followed. However, we're still lacking a formal Institute Policy that could take the burden of asking and organizing off the shoulders of the person in need—something that would make our institute even more equitable.

Until Jackie Hodge arrived in 2015, I did not realize how much I missed a female perspective and camaraderie, and also, to be honest, the possibility of sharing responsibilities and duties that required 'a woman in the committee'. Later, more female colleagues joined the institute, we are now nearly 10 in total!

Between 2017 and 2022, four of us were the target of inappropriate behavior. In my case, that was a noxious and misogynist slandering and bullying campaign. When we filed our complaint, nearly twenty witness statements from our Leiden Observatory colleagues were handed over to the investigating team, corroborating our accusations. After ten years since my negative experience in the GRB field, I had finally learnt to stand up to inappropriate behaviour. Now I think that this was another experience that made both the department environment and me stronger and better, and I will never forget the unwavering support of many of you in the audience.

In terms of career development, after securing a permanent position, I have increasingly focused on scientific community service, particularly within the context of space missions, driven by my deep personal interest in LISA. Since 2006, I have been an active and committed member of the International LISA Community, now a {\it Consortium}. As a core member, I played a role in the successful proposal to the European Space Agency (ESA) in 2017, which ultimately convinced them to embark on the LISA mission. Now, LISA is no longer just an

idea—it's a reality: the mission is under construction and is set to launch in 10 years!
One of the things I truly enjoy about this journey is collaborating with my colleagues in the LISA Consortium. Some of them are here today, both in person and online: I have a great time working with you! It's been such a rewarding adventure—one that started with that very first conversation with Peter Bender.

On a national level, I've worked alongside Gijs Nelemans and others for many years to organize the LISA scientific community here in the Netherlands. Together, we've helped solidify and expand the Dutch leadership in preparing for the LISA mission. Our efforts --especially Gijs'--have already been successful, and we got an added boost a few years ago when SRON, the Dutch Space Research Organization, increased its involvement in the mission: thanks Mike and Terri!

At a broader level, I work closely with the ESA to make sure that space missions are selected, designed, and operated to achieve the best possible scientific results, and that the scientific community feels heard and supported throughout this process; I admire the dedication and enthusiasm of my ESA colleagues -- Nora, Paul, Martin, and now Lorenzo -- and I feel we genuinely share the same goals.

Among all this "excitement" and community services, I have also had the privilege of conducting fascinating research at Leiden. You've already heard about my work on galactic centre phenomena, which I began in Jerusalem and continued in Leiden, focusing on matching theoretical models to observational electromagnetic data. But in Leiden, I have also intensified my research in both investigating the structure of our own Galaxy, the Milky Way, and in {\bf gravitational wave astrophysics}.

This involves using \textbf{gravitational waves} to explore the cosmos, either alone or alongside light. Gravitational waves are ripples in space-time, and my research focuses on those produced by interactions between black holes or compact "dead" stars, called {\it white dwarfs}, bound together by gravity.

In the summer of 2015, physics was rocked by a groundbreaking discovery: the first detection of gravitational waves by the LIGO interferometer, a pair of detectors based on Earth. Although I was not involved in the LIGO detection, you can imagine how happy I was personally! And with me all the scientists who had for many years speculated on the use of gravitational waves for science and invested time in the realization of the LISA mission, {\it before} we had a definitive proof that gravitational waves even existed at all! This visionary calculated risk that may bring unprecedented discoveries, and the excitement that comes with it is, I believe, what keeps us in the core team of the LISA Consortium going. What could be more exciting than taking a risk and seeing it pay off?

That first detection immediately raised new questions, particularly about the formation of small black holes from the deaths of massive stars. The signal came from two black holes, each about 30 times the mass of our Sun, at least three times heavier than previously observed in electromagnetic waves. Stellar physics couldn't easily explain their existence! Since then, nearly 100 gravitational wave signals have been detected, including from mergers of even heavier black holes. So, why are these black holes so massive?

This is what Niccolò Veronesi, whom I co-supervised with Sjoert, set out to explore in his thesis. His research focused on whether these events could occur in the gas-rich environments of MBHs in galactic centers. The idea is that gas could capture black holes, increasing their chances of merging and allowing them to grow by consuming other black holes and/or gas.

Niccolò designed an experiment to match the locations of gas-rich galactic centers with gravitational wave signals. We expected larger black holes, found in more gas-rich environments, to produce these events. However, the results were surprising: only about 10% of the signals seemed to come from those galactic nuclei. This led us to consider that smaller MBHs in less gas-rich environments could be responsible for most mergers, instead. Niccol's work has sparked much research in the field, and I am sure his thesis is soon to earn prestigious honours and perhaps prizes.

Zooming out of galactic nuclei, gravitational waves can also be used to study entire galaxies. Valeryia Korol's thesis proposed the innovative concept of "be-messanger galactic studies" where she showed how the anticipated LISA observations of white dwarf binaries can be used to "image" and explore our Galaxy, as well as neighbouring galaxies in a manner similar but complementary to how astronomers have studied galaxies using optical light for over a century. In fact, she showed that the simultaneous use of Gaia and other optical surveys data together with LISA data can achieve more than the use of each dataset separately. Her thesis --which gathered prizes and fellowships --greatly benefitted from the guidance of her co-supervisor, Paul Groot, and that of Anthony Brown, who has always been an invaluable collaborator at Leiden for myself and my students working on Galactic topics.

If gravitational waves can trace the stellar component of a galaxy, luminous stars allow us to detect through their motion the presence and distribution of dark matter, the major component in mass of a galaxy. This was the goal of Stella Reino's thesis, where she used long streams of stars observed in the Galactic halo to measure the elusive distribution of dark matter in our own Galaxy. Stella's measurement of dark matter is still highly relevant and cited today. This result could not have been possible without Robyn Sanderson (University of Pennsylvania), Stella's co--supervisor, and the experience of Koen Kuijken and Elena Sellentin in Leiden: another great team, which I had the privilege to bring together and work with!

Conclusion

As I wrap up, I want to reflect on how each step of my journey has shaped me into the academic I am today. This journey has made me scientifically versatile, with a focus on connecting diverse fields of study. It's also instilled in me a sense of enthusiasm, optimism, and vision for the future. I'm deeply committed to fostering an environment that promotes fair and professional growth, both for my students and the scientific community at large.

I am excited to explore unknown territory and excited to have the opportunity to enable scientific goals that transcend my own ambitions. But above all, I recognize that science is a collaborative endeavour. All of my successes—if you can call them that—are the result of the stimulating interactions, brainstorming sessions, and partnerships with my teachers, colleagues, and students. I am also deeply grateful for the stability and fulfillment provided by my friends and family. As John Donne once wrote, 'No man is an island,' and a female astronomer is no exception.

So, to all of you—thank you. I could not have become the academic I am today--the academic I meant to be--without your support, encouragement, and friendship. And...Alma, Sofia: I wish I could wave my wand and say "Wingardium Leviosa!" or "Obliviate!" or "Expecto Patronum!", but I can't. What you have heard today is the closest to Magic that Mamma can produce, and you are a part of it.

Prof.dr. Elena M. Rossi

Professor Elena Maria Rossi obtained her PhD at Cambridge University in the UK in 2005. She then held a NASA Chandra fellowship at the University of Colorado in Boulder, a postdoctoral position at Hebrew University in Jerusalem, and was hired in 2011 at Leiden Observatory. In 2022, she was appointed full professor in Theoretical Astrophysics.

Prof. Rossi is an internationally recognised astrophysicist specialising in the study of dynamics and hydrodynamics around compact objects, the formation and evolution of supermassive black holes, and gravitational wave astrophysics. Focusing on using phenomena related to compact objects as innovative tools to investigate galaxies and galactic nuclei, she has made significant contributions through theoretical models, numerical simulations, and large-scale observational data, including Gaia data. She has received highly competitive international and national awards, such as an ERC Consolidator and the NWO Vici grants. Since 2018, she has held prominent positions within the Laser Interferometer Space Antenna (LISA) International Consortium and is a member of the European Space Agency's (ESA) LISA Science Team, a select group of 20 international scientists responsible for ensuring that the scientific goals of the LISA mission are met. She chairs the ESA Astronomy Working Group and is a member of the ESA Space Science Advisory Committee, the highest advisory board for the ESA science programme.

Universiteit Leiden