

Science AMA Series: I am Dr Sarah Malik, a dark matter researcher in Imperial College London’s High Energy Physics Group. My current research is using the Large Hadron Collider at CERN to searching for particles that make up ‘dark matter’. AMA!

DrSarahMalik¹and/ScienceAMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Hi Reddit! I’m Dr Sarah Malik, a dark matter researcher at Imperial College London in the United Kingdom. In October 2015 I was awarded a grant from the Royal Society to carry out research on producing and detecting dark matter using the Large Hadron Collider (LHC) at CERN. I find it fascinating that more than 80% of matter in the Universe is invisible to us, it doesn’t emit or reflect radiation. This is what we call “dark matter”. We know it exists because it exerts a gravitational force on ordinary matter, playing a critical role in holding together galaxies and shaping the Universe as a whole. There’s reason to believe that it comprises particles that have mass, are electrically neutral and don’t decay; beyond that, we have little understanding of dark matter. How many types of dark matter particles are there? What types of forces do they exert on each other and on the ordinary matter particles? My current research aims to address these very questions. Discovering what 80% of matter in the Universe is made of will play a significant role in defining the future direction of particle physics and cosmology and mark an extraordinary development in our understanding of the world around us. I will be back at 2pm ET to answer you questions, ask me anything! Proof: <https://royalsociety.org/people/sarah-malik-7571/> http://lpc.fnal.gov/fellows/Sarah_Alam_Malik.shtml To learn more about me and my research, follow me on Twitter (@SarahAlamMalik <https://twitter.com/SarahAlamMalik>). You can also see me talk about dark matter at the 2015 Blakett Colloquium (<https://youtu.be/BHa65maMIFk>), and on the Guardian ‘Big Unknowns’ podcast (from 16:36) (<https://www.theguardian.com/science/audio/2016/nov/22/big-unknowns-what-is-dark-matter-science-weekly-podcast>). Update Happy Dark Matter Day everyone! I’ll be live for the next hour or so answering as many of your excellent questions as I can. Update That’s me signing off now. Thanks so much for your questions and contributions. I’ll be checking back in from time to time, so feel free to keep the conversation going. Happy Dark Matter Day!

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DR_SARAH_MALIK [R/SCIENCE](#)

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Proof: <https://royalsociety.org/people/sarah-malik-7571/> http://pc.fnal.gov/fellows/Sarah_Alam_Malik.shtml

To learn more about me and my research, follow me on Twitter (@SarahAlamMalik <https://twitter.com/SarahAlamMalik>). You can also see me talk about dark matter at the 2015 Blackett Colloquium (<https://youtu.be/BHa65maMIFk>), and on the Guardian 'Big Unknowns' podcast (from 16:36) (<https://www.theguardian.com/science/audio/2016/nov/22/big-unknowns-what-is-dark-matter-science-weekly-podcast>).

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CORRESPONDENCE:

Could you summarize the recent dead-ends : those experiments that searched for dark matter candidates and failed?

[moschles](#)

DATE RECEIVED:

November 01, 2017

We've been looking for dark matter in the form of WIMPs (Weakly Interacting Massive Particles) in three main types of experiments:

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- space based experiments
- deep underground experiments looking for a galactic WIMP scattering off one of the nuclei in their detectors
- trying to produce them directly in particle accelerators.

So far, we haven't seen any convincing evidence for WIMPs at these experiments. BUT, these experiments are entering a new phase of operation with bigger and better detectors and they expect to have much greater sensitivity to discovering WIMPs than ever before.

So stay tuned!

Is dark matter only free floating individual particles or is it possible that there are dark matter equivalent of planets or other objects?

Also are there any theories on how dark matter interacts with black holes? Do black holes capture dark matter the same way they do everything else?

[Awesome5auce](#)

Since we know very little about what dark matter might constitute we don't know how simple or rich the dark sector might be.

However, given the degree of complexity in our visible sector, we have started exploring the idea that the dark sector could also be very rich, with a spectrum of new particles and forces that govern how they interact with each other.

The theories connecting dark matter to black holes typically look to see if black holes (especially primordial black holes in the early Universe) could explain our 'missing mass' problem.

Thanks for the AMA, Dr. Malik.

I'd like to ask what results you have obtained in the two years you received the grant. Also, do we have any knowledge at all about any properties of dark matter?

[useful_person](#)

Hi, I've been analysing the latest data from the LHC at the collision energy of 13 TeV, which is the highest energy ever achieved by a particle accelerator, and using this data to search for the production of dark matter particles in a wide range of possible theoretical scenarios (essentially casting a really wide net since we don't know what this stuff is).

The theoretical scenarios include Supersymmetry (the most popular theory for explaining some of the shortcomings of our current theoretical framework and going beyond it) which predicts a whole bunch of new particles, one of which has all the right attributes to be an excellent dark matter candidate.

Our knowledge about dark matter is pretty limited. If it is made of subatomic particles, we know some of the properties this particle should have; it should have mass, be stable and long-lived and be electrically neutral.

Everything you are doing is way above my level of comprehension. What made you decide to get into the field of Dark Matter in the first place?

[stangg](#)

I thought it was extraordinary that everything on Earth, everything that we've ever observed with any of our instruments only makes up a mere 5% of the content of the Universe and the other 95% we know very little about.

This realisation is a game changer in terms of one's perspective of how we view ourselves and our place in the cosmos. More than a quarter of the Universe is made of this stuff, I want to know what it is :)

Welcome,

Since we cannot see nor directly detect dark matter particles, what signals do you search for to draw inference?

[adenovato](#)

At the Large Hadron Collider, the production of a dark matter particle will look very similar to another elusive particle that we DO know about, the neutrino.

The existence of the neutrino was postulated by Pauli back in 1930 when he observed that energy was not being conserved in radioactive decay and hypothesized that this was possibly due to an electrically neutral particle carrying away some of the energy.

We expect to infer the existence of dark matter particles at the LHC in the same way, we look for them being produced together with some other particle or collection of particles, apply momentum conservation and look for an imbalance in momentum.

How are you searching for the particles that make up Dark Matter?

And happy Dark Matter day!

[LordGuille](#)

Thank you - it's also Halloween :)

One of our best guesses for what dark matter might constitute is a class of subatomic particles called Weakly Interacting Massive Particles (WIMPs). We currently have three classes of experiments that are looking for WIMPs in independent and orthogonal ways; space based experiments looking for the products of two dark matter particles coming together and annihilating and producing stuff that we can detect.

We have detectors deep underground to look for a galactic WIMP coming in and scattering off a nucleus in the detector and last of all we are trying to see if we can produce these particles in the lab at the Large Hadron Collider so we can study them.

How will the discovery of dark matter particles change the way we view the universe? Would it answer questions or simply add more unknowns into the equation?

[PeaNuts12345](#)

The discovery of dark matter particles would be a major breakthrough in our understanding of the Universe.

The way it changes our view of the Universe would depend on what it is we find and how this stuff

interacts with us. Is there more than one dark matter particle? Is it part of some complex Dark Sector with its own interactions?

The discovery will likely throw up as many question as it answers. :)

Hi Sarah, thanks for doing this AMA!

Of all the scientific fields, theoretical physics seems to captures people's imagination more than most, especially when it comes to strange and elusive concepts such as dark matter, quantum states etc.

I wanted to ask if you think the evidence base is actually increasing and we are on track to make tangible breakthroughs, or whether the theories are becoming increasing complex and 'out there' to accommodate what we don't know, can't see or have failed to find?

Thanks very much!

[Ryanosaurus_Rx](#)

Thanks for the interesting question. This relationship between theory and experiment is an interesting one, we build experiments to test certain well motivated theories and the results from these experiments can also throw out many theories and tell us that we need to get smarter.

In my opinion, we're at a particularly pivotal stage with respect to our theories about dark matter. Our most studied and perhaps well motivated theory is that dark matter is composed of a class of subatomic particles called Weakly Interacting Massive Particles (WIMPs).

We have a lot of very good reasons to go down the route of WIMPs but if the next generation of experiments directly searching for these particles do not see anything, it might be time to go back to the drawing board!

Hello Dr Malik, I was interested that dark matter particles are thought to have mass. How small is this mass likely to be, given that it doesn't interact with ordinary matter? What's the smallest mass we can currently detect? Thanks!

[Flakkarin](#)

Thanks for your question. It's not so much the mass that is the issue. We can observe photons (particles of light) in our detector even though they are massless because they interact with charged particles and thus leave a visible trace in our detectors.

The detection of dark matter particles is challenging because they carry no electric charge and interact very weakly with ordinary matter.

Is your research team/department doing anything fun for Dark Matter Day?

[lorantz](#)

Hosting a Dark Matter Day AMA on [r/Science](#) is lots of fun for us! :)