Herschel and the invisible end of the rainbow

A play by:

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How the discovery of infrared radiation by the siblings Caroline and William Herschel might have happened...

Inspired by the scientific publications of William Herschel:

Philosophical Transactions of the Royal Society of London, Vol. 90 (1800), pp. 255-283, pp. 284-292, pp. 293-326 und pp. 437-538

Published in the context of the FWF science-communication project:
“Herschel and the invisible end of the rainbow”
Project lead: Franz Kerschbaum, Department for Astrophysics, University of Vienna

Website:
https://space.univie.ac.at/projekte/rainbow/

ACTING CHARACTERS

William Herschel

Male, 55 years old, grey hair, wig, frock coat

Born in Hannover, Germany, studied musician and hobby scientist

Absorbed by his scientific work and slightly absent-minded

Caroline Herschel

Female, 40 years old, pinned up hair, dress with large underskirt

William's younger sister, born in Hannover, Germany, raised as housekeeper according to the classic female education back in the days, trained by her brother to be a scientist

Helping her brother with science and housekeeping, acting out her own thirst for knowledge

STAGE SETTING

A study with scientific instruments, construction parts for telescopes, old books, writing utensils.

Worktable and writing table

A window

A mirror

A door

A case holding a prism, a small mirror, and two thermometers

A teapot and two teacups

INSIDE – WORKROOM – DAY

A large table is in the middle of the room, on top of it there is a big chest. Near it there is a desk with several papers visibly covered in jotted down notes. Right beside the chest there stands a tall mirror.

The Narrator enters the stage, stands in front of the working table and speaks to the audience.

NARRATOR

Good day, dear scientists! You might be wondering where we are! Welcome to the year 1800 and the house of the Herschel siblings, William and Caroline. At this point, William Herschel was already a celebrity, thanks to his discovery of the seventh planet Uranus. Before him, only six of the eight planets in our Solar System had yet been discovered. His sister, Caroline, had also made a name for herself as a scientist thanks to her discovery of several comets in addition to her many years working together with her brother. At the time, this was quite something, since the role of women in science back then was strictly limited. Fortunately, today this has changed!

The Narrator takes a few steps towards the audience.

NARRATOR (CONT'D)

The peculiar thing about these two siblings is that they were not “real” scientists, that is to say… at least not in the studied, academic sense. They both were amateurs, like…

(The narrator points at a person in the audience.)

... like you and me... uhm well, wait a minute, you probably studied something, didn't you? I mean, you sure look quite smart…

(The Narrator points at a different person in the audience.)

...like you and me! Alright then, both were not professional scientists BUT…

(The Narrator pauses dramatically)

...both were musicians – very successful musicians – like the Rolling Stones of the day, known all over England. Men wanted to be as good a musician as William and women wanted to sing as great as Caroline, and then … Yeah, right, what do you do when you are one of the most distinguished musicians in the country? Exactly! You give everything up and pledge yourself to the stars! That is exactly what they did! Together, William and Caroline searched the skies, night and day (mostly at night, to be precise), and built bigger and bigger telescopes to explore the firmament. Today however, the Herschel siblings are going to make a discovery that has nothing to do with telescopes or the night sky. For today they will investigate a completely different thing, something that was meant to change the world, even if it did

not look like much at first glance
… but see for yourself!

The Narrator leaves the stage.

William, 55 years old, grey hair, enters the room, stands in front of the mirror and mumbles to himself.

WILLIAM
Dear gentlemen of the Royal Society…

William observes his belly in the mirror, pushes it out and pulls it in again.

WILLIAM (CONT'D)
Did I put on some weight?

William taps his belly. Caroline, 40 years old, enters the room and remains unnoticed a few steps away, observing him.

WILLIAM (CONT'D)
(with a low voice)
Dear Royal Society, dear gentlemen **...** should I pay closer attention to my diet?

William turns to observe his belly in the mirror from the other side.

WILLIAM (CONT'D)
(with a higher voice, imitating his sister's voice)
Or should I rather eat more of those wonderful English vegetables?

William turns with a pirouette, discovers Caroline and stands petrified.

WILLIAM (CONT'D)
(insecure)
...how long have you been standing there?

CAROLINE
Too long… believe me, William... definitely too long!

William puts his clothes in order.

CAROLINE (CONT'D)
So I see you are practicing your speech. And? How far did you get?

WILLIAM
(hesitant)
Did you hear “Dear gentlemen of the Royal Society” already?

CAROLINE
Uhm... yes…

WILLIAM
Well... not much further, really.

CAROLINE
William! How long do you want to put this off? And besides, why only “gentlemen of the Royal Society”? Will I not also be there?

WILLIAM
You are absolutely right, Caroline! And believe me... We need more women like you in science! I am convinced … soon it will be you standing in front of this mirror practicing your own speech.

(incidentally)
I only hope you will make a better figure than I do now.

The Narrator nods his head in agreement.

CAROLINE
It is about time that you men give us a voice. But let’s leave that for now and get back to your speech!

WILLIAM
(somewhat contrite)
I know, I know… the thing is that I have absolutely no idea what I should present this year! You know … building the new telescope took most of our time and energy. And on top of that, now this speech … I can’t bring myself to write it. There is so much work for me – for us both – to do.

CAROLINE
William... I don’t know why you are so stressed about it! Simply tell them about your new telescope.

William shrugs his shoulders in discomfort.

WILLIAM
(stubbornly)
Well, I can’t show up empty handed, without a discovery! What would people think? They will think that I’m just some amateur!

CAROLINE
(appalled)
What? William, how can you think such a thing? Nobody, not even for a minute, thinks you’re an amateur!

William turns his head towards the Narrator.

WILLIAM
That one over there does. Didn’t you hear him before?

Caroline looks at the Narrator and shakes her head.

NARRATOR
I didn’t mean it that way! I …

CAROLINE
(interrupting)
Anyway, some people are better off keeping their mouths shut. Yesterday, that one over there didn’t even know his text yet. Don’t mind him! In the worst case scenario you can always tell them again how you discovered Uranus. I mean, William, really... people like Sir Albert will be sitting in this audience.

At the mention of the name “Sir Albert”, William looks at Caroline.

CAROLINE (CONT'D)
Exactly, that Sir Albert. Do you remember his “lecture” last year? Half the audience fell asleep!

NARRATOR
(to the audience)
Hopefully that won’t happen again today!

Caroline rolls her eyes and shakes her head.

CAROLINE
Well, William, back to work. Let’s hear your speech. How far are you?!

Caroline looks at William with expectation.

WILLIAM
Alright, alright... Dear Royal Society, dear gentlemen,
(to Caroline)
dear lady, it is both an honour and a great pleasure for me to stand before you this year again. My newest experiments show that... that... that...

William looks at Caroline seeking for help.

CAROLINE
(snappy)
... that I spent practically all my earnings in building even bigger telescopes again this year? That because of that we had to count down to the very last penny…

WILLIAM
Caroline...

CAROLINE
Or that my sister has hardly slept at all in the last three weeks, because she had to catalogue star clusters with me?
(laughing)
Well, you probably shouldn’t mention that in your speech!

WILLIAM
(mildly offended)
Well, you also benefited from it, didn’t you? Think about it, all the things you have already achieved. Everything you already discovered. Caroline Herschel: the comet hunter. Known all over the world. Supported by the king!

CAROLINE
(tauntingly)
With 50 Pounds a year…

WILLIAM
I know it is not much, but think of what an honour it is. You are the first female scientist with a salary!

Caroline goes to William, arranges his jacket and lovingly caresses his face.

CAROLINE
I know, I know. Can you imagine? Here we are. It is not that we were nobody before. You, one of the greatest musicians in England. Director of the orchestra of Bath. Known and admired everywhere.

WILLIAM
And you, a highly respected singer. One of the best in England for sure!

William takes Caroline's hand.

WILLIAM (CONT'D)
And? Do you regret it Caroline?

Caroline looks down.

CAROLINE
That we left our successful musical careers behind completely? That we gave up our financial security?...

Caroline makes a brief reflective pause.

CAROLINE (CONT'D)
Sometimes... But you know, William... When I'm standing in our garden at night, looking through our telescope at the fantastic starry sky... Then I know that all of our efforts were worth it! And you?

WILLIAM
You know I loved being a musician. But I was also always fascinated with the study of the stars. Perhaps you can't remember but as a child I used to endlessly talk with father about the stars during our evening walks. He taught me everything, feeding my curiosity to know more.

CAROLINE
Of course I remember! I used to secretly follow you on your evening walks. I would look up to the skies and just wanted to know more, to understand more.

WILLIAM
(laughing)
You were always such a curious child... And now, look where that curiosity has brought us! In music everything was so rigid, so arranged... I felt somehow constrained, limited!... You know what I am talking about... It was time to go beyond those constraints again, time for a change... that's how we ended up looking back up to the stars!

Here we have the chance for something really new. And that is exactly what helped me – us – in the discovery of Uranus. It was only by looking into the unknown, looking beyond Saturn, that such a discovery was possible.
By pursuing our passion... For sure you remember when we built our first telescope. How much time and money we invested in it. It was not without pain that we strived for our passion! But then... when it was ready and we finally could see the firmament in such detail... The first gaze through our own, self-built telescope... that is something I will never forget! Ultimately we can say that it was our curiosity that brought us here.

CAROLINE

(nodding)

And how! Everybody thought there were only six planets. And you proved that there are more than previously thought!

WILLIAM

And all thanks to you, my little sister!

Somebody knocks at the door. Caroline opens the door ever so slightly.

CAROLINE

Good morning Sir Highsbury! Ah, you would like to speak to my brother... Please, come in, he is right here...

Caroline opens the door a bit while William clearly gestures he is not ready for a visit.

Caroline promptly closes the door again, except for one narrow slit.

CAROLINE (CONT'D)

I’m sorry, he was right here. But then he had to leave for an important meeting... When does he get back?... Well, no idea... Did he already put together an article about his latest discovery?

Caroline flashes William a glance, and he shakes his head in reply.

CAROLINE (CONT'D)

Well, to a certain extent. He will send you the papers as soon as possible... Ah, you’re coming back again in the afternoon... Alright then... Yes, thank you very much... Goodbye!

William paces nervously around the room.

WILLIAM
This damned speech... if only I knew, what to present this year. It is driving me insane!

William seems increasingly agitated, and starts to shiver.

WILLIAM (CONT'D)
But with this cold... It is impossible to have a clear thought... Is the stove already on?

CAROLINE
Yes, indeed. It just takes a bit until it gets warm in here. But why don't you go over there and stand next to the window? The sunshine will warm and comfort you.

William goes to the window. Caroline fills a cup with tea, walks over to William and puts it in his hand.

CAROLINE (CONT'D)
And here you are, a sip of tea will warm you from the inside!

William takes a large sip from the cup.

CAROLINE (CONT'D)
Normally we're up all night observing the stars. Let's enjoy the one star we can best see during the daytime for once!

Caroline also pours herself a cup of tea. William looks through the window, absorbed in his thoughts.

William looks towards the sun. Caroline joins him.

WILLIAM
Now, looking at the sun... When I think of the ways humans have tried to explain the phenomenon... I mean, think of ancient Greece... They used to believe that there

was a sun-god by the name of Helios, who would carry the sun every day in a chariot pulled by four horses, driving it through the skies. Can you imagine, Caroline? Pure madness!

Caroline nods in agreement.

CAROLINE
As well as their own god of light!

WILLIAM
Precisely! And there you see why science is and always will be so important. You may see something with the naked eye, and try somehow to explain it. The diurnal motion of the stars across the sky, for example. But people will come up with the wildest of explanations. It is only through science that we can shed light on those observations. Same as the god of light in ancient Greece. And that is the reason he was worshipped. As the god of light people thought he would be able to see everything, enter anywhere, and nothing would escape his sight. In essence, it is not very different to what we do with our telescopes...

CAROLINE
Exactly! Observations that would otherwise remain invisible to the naked eye. As you like to say: “let's think outside the box”

Both look through the window.

CAROLINE (CONT'D)
Do you think it will rain tonight?

WILLIAM

(sarcastic)
Caroline, we are in England. It would be a miracle if it didn’t rain today.

Caroline goes to the table and reads through some of her notes.

CAROLINE
(casually)
As long as there is some sun... Then there's the chance of a rainbow!

WILLIAM
Rainbow... That gives me an idea!

William goes to his desk, rummages inside a case and takes out a prism.

WILLIAM (CONT'D)
Do you see this prism? Sir Isaac Newton found out that light is naturally white, yet composed of all the colours of the rainbow together. Lately, I have done some experiments with it. Look at this, Caroline. There is no need to wait for the rain!

William places the prism on a mount on his desk. The light goes through the prism, and the full colour spectrum appears on the work surface.

CAROLINE
(excited)
Beautiful!

WILLIAM (CONT'D)
(smiling)
What would the ancient Greeks think of this? Now that we have deconstructed their god of light into his fundamental components...

Caroline takes the prism, holds it in the air and observes it carefully. Then she places it back to its original

position. William shivers and rubs his hands against each other.

CAROLINE
Are you still cold? The stove should be hot by now!

William nods. Caroline looks at the “rainbow” in front of her.

CAROLINE (CONT'D)
That gives me an idea. Standing in the sunlight did warm you up, didn’t it? That means that sunlight, the normal white light from the sun, emits some heat. Do you think that the different colours of the rainbow emit different amounts of heat? Let’s find out! Which colour emits the most heat of all?

WILLIAM
That is an excellent idea, Caroline. Let me get the thermometers.

William goes to a chest near the desk and rummages around in it.

CAROLINE
Wait. Before we begin measuring... Let’s use the thermometers with the black tip.

WILLIAM
Ah, because they warm up more easily?

CAROLINE
(amused, enthusiastically)
Precisely! That will make our measurements a lot easier!

William grabs two thermometers.

CAROLINE (CONT'D)

Come on, William, let's try.

WILLIAM

Alright, let's measure together. I will take this thermometer here, the so-called control thermometer, and place it by my side. We will later measure the room temperature with it. I will give you this

(William hands one thermometer to Caroline.)

second thermometer, with which you will measure take a reading inside the colour spectrum. Let's first compare our thermometers. What temperature is shown on your thermometer, Caroline?

CAROLINE

19 degrees. It is indeed a bit cold in here.

WILLIAM

Very good. I mean, it is not very good that it is cold in here, but the fact that both thermometers work properly. Mine also shows 19 degrees. Well then. Now place the thermometer within the blue part of the spectrum.

William takes up pen and paper, while Caroline goes to the table and places the thermometer in the blue light range of the spectrum.

CAROLINE

Now we have to wait a little while!

WILLIAM

Well then, which temperature is it showing in the blue light region?

CAROLINE
19.3 degrees!

William writes down the measurements.

WILLIAM
19.3 degrees. Warmer than the room temperature! Well now, let's measure the green region!

CAROLINE
(waiting a bit longer)
19.6 degrees.

William writes down the results again.

WILLIAM
(mildly euphoric)
Oh... there seems to be a difference here!

CAROLINE
We are not done yet! Who knows what we will find in the red region.

WILLIAM
Alright! Place the thermometer in the red region, then!

Caroline places thermometer in the red region.

CAROLINE
Red region, 19.7 degrees.

WILLIAM
Even warmer than the green region! There seems to be a difference between the beginning and the end of the rainbow. For we measured a clearly lower temperature in the blue light!

CAROLINE

Yes, the different colours of the visible spectrum appear to be emitting different amounts of heat.

WILLIAM
I think now I finally have something that I can present to the Royal Society!

William and Caroline go to the desk together and scribble down notes. The Narrator enters the stage. In the background, William and Caroline keep going back and forth to the thermometers, writing down their notes on the desk.

NARRATOR
It was at this point that the Herschels discovered that the temperature of the light spectrum continuously increases from blue to red. At the time they were without an explanation. Today we know that it is the deviation of the wavelengths created by the prisma, that is responsible for this phenomenon.

WILLIAM
(murmuring to himself, while writing)
...it shows that the temperature in the red region is clearly higher than the one in the blue region, and that of the green region as well.

Somebody knocks at the door.

CAROLINE
(shouting)
Coming!

William continues with the notes. Caroline leaves a thermometer in the area beyond the red spectrum and rushes to the door. She opens it slightly.

CAROLINE (CONT'D)

Ah, good afternoon Sir Highsbury! You're probably wondering if my brother got back already...

Caroline sends a piercing glance to William, but he is so immersed in his work that he doesn't even notice.

CAROLINE (CONT'D)
(louder)
...if he got back!

Caroline looks again at William, again to no avail.

CAROLINE (CONT'D)
(even louder)
...whether my brother is already back???

This time Caroline stamps her foot on the floor, which jolts William and makes him take his sight away from his notes.

CAROLINE (CONT'D)
(abashed)
... I am fine, Sir Highsbury, thanks for asking! You know, all the work I've put into my brother's new telescope... well that's really been keeping me hard at work the whole time of late. My brother…

William silently gestures that he's not there.

CAROLINE (CONT'D)
...Well, sadly no, he hasn't come home yet. These scientists!... He probably went somewhere to find a new mirror for our telescope... I am certain, that he will be back today... ah, you'll be back in an hour?... very well... See you then!

Caroline closes the door, leans her back against it and takes a deep breath.

CAROLINE (CONT'D)
Phew... that was close. I won’t be able to stall him one more time, William!

William continues writing his notes and nods his head absent-mindedly.

CAROLINE (CONT'D)
Can you actually hear me at all?

William nods distractedly.

CAROLINE (CONT'D)
William, there is no need for stress anymore. Sir Highsbury has just told me that your presentation has been cancelled…

Caroline looks at William, waiting for some kind of reaction.

WILLIAM
(absent)
That is good, that is very good.

CAROLINE
Instead, they plan to award you some kind of prize...

WILLIAM
(absent)
Great, I am so glad!

CAROLINE
And I will be the next Queen of England. I just received the request! The only thing to check now is whether or not the crown fits!

WILLIAM
(absent)
Very good. Keep up the good work!

Caroline claps her hand together loudly, which makes William look away from his notes.

CAROLINE
(grumpy)
I know that you are not listening at all.

WILLIAM
(looking back to his notes)
How high is the control temperature in this room? Really 19 degrees?

Caroline goes to the last thermometer and reads the temperature.

CAROLINE
(confused)
19.9 degrees.

WILLIAM
(mildly shocked)
19.9 degrees? Which thermometer are you looking at?

CAROLINE
(pointing at her thermometer)
Well, this one over here. I just left it there!

WILLIAM
And what about the control thermometer?

William looks at the thermometer by his side.

WILLIAM (CONT'D)
19 degrees!

CAROLINE
How curious. Yours is still measuring 19 degrees. How can this thermometer show 19.9 degrees?

WILLIAM
Let me have a look!

William joins Caroline at the desk and observes the thermometer which lies beyond the red part of the spectrum.

WILLIAM (CONT'D)
It is true, it measures 19.9 degrees. How can that be possible? Have you perhaps touched it somewhere? Maybe as you were opening the door to Sir Highsbury?

CAROLINE
No, as he knocked at the door, I placed it exactly here.
(Caroline points at the surface in front of her)
And since, I haven't touched it anymore, just read it.

WILLIAM
Here
(William points at the surface as well)
did you place it here? Right beside the rainbow?

Caroline thinks briefly.

CAROLINE
Yes, that is how it happened.

WILLIAM
How can that be? Here there is no light whatsoever!...

CAROLINE
Let's stick to your motto and…

Caroline moves her hand through the empty space beyond the visible spectrum.

CAROLINE (CONT'D)
...let's think outside the box. Let's get another reading of the temperature!

Caroline takes her thermometer and places it again in the area beyond the red region of the spectrum.

WILLIAM
Now I am really excited!

CAROLINE
Unbelievable but true, it still measures 19.9 degrees. How can it be 19.9 degrees there? Where would the heat come from? And what about the control thermometer…

Caroline goes to the control thermometer.

CAROLINE (CONT'D)
...still at just 19 degrees.

WILLIAM
Did I by any chance put my cup of tea here?

CAROLINE
No, it was by the window the whole time! It can't be the cause!

WILLIAM
Really strange! Now take the control thermometer with 19 degrees…

William takes the original thermometer originally used as control and gives it to Caroline. Caroline places it in the area beyond the rainbow.

WILLIAM (CONT'D)
...and place it now over here. Right beside the rainbow!
(to the Narrator)
And you didn’t touch anything here either?

NARRATOR
I was just standing here the whole time.

WILLIAM
Unbelievable. It’s now reading 19.9 degrees.

CAROLINE
Strange. Then both thermometers show precisely 19.9 degrees when placed here. Ok then, let’s think. The light here is dispersed into the different colours.
(Caroline points at the “rainbow”)
Perhaps there is some other kind of sunlight, an invisible one...

WILLIAM
An invisible one?

CAROLINE
Well, I mean... some kind of light that is not visible to our eye. But we could also test that!

WILLIAM
That’s right. If we are dealing with some kind of invisible light, we should also be able to reflect it with a mirror. Come on, let’s try that out.

William picks up a mirror, Caroline is standing ready with a thermometer.

WILLIAM (CONT'D)
How many degrees do you measure in that area over there?

William points at an empty area on the table next to Caroline.

CAROLINE
19 degrees. Room temperature.

William moves the mirror and reflects the light from the invisible part of the spectrum to the other end of the table, where Caroline is standing ready.

WILLIAM
So, I will now try to reflect that invisible light with this small mirror over here. Let’s see whether it warms up or not. That would be fascinating. I can’t wait!

Caroline takes her thermometer and measures.

WILLIAM (CONT'D)
(impatiently)
And?

CAROLINE
(delighted)
19,9 degrees!

WILLIAM
It is really true. There is such a thing as an invisible light!

William scratches his head in disbelief.

WILLIAM (CONT'D)
What a day! And I was already fascinated by the different temperatures in the different colours of the rainbow! And now this! An invisible kind of light!

CAROLINE
Invisible and warmer than all other colours.

WILLIAM
I must write it down right away!

William goes to his desk and begins to jot down on some pages.

WILLIAM (CONT'D)
I can’t wait to present these discoveries to the Royal Society!

CAROLINE
And just 20 minutes ago you wanted to call in sick... how fast does the tide turn... but... all the things this discovery will make possible…

Somebody knocks at the door.

CAROLINE (CONT'D)
That is surely Sir Highsbury!

WILLIAM
(jotting down frantically)
Stall him just a minute!

Caroline goes to the door.

CAROLINE
Good evening Sir Highsbury! Whether my brother is already done with his scientific papers for the presentation?

Caroline looks at William, who indicates her to stall Sir Highsbury just a bit longer.

CAROLINE (CONT'D)
Yes of course he is done. Oh, by the way, another thing I've been meaning to ask you. How is your mother doing? She was wearing a most gracious garment last time I saw her... Whoops, that was your wife? Please excuse the misunderstanding...

WILLIAM
Caroline!

William gives Caroline a pile of pages. She looks at them and reads the title aloud.

CAROLINE
(reading out)
The invisible end of the rainbow!
(to William)
I like the title.

The room dims out.

NARRATOR
On this day the Herschel siblings discovered infrared light. The light beyond the red end of the rainbow.

In the background, the Herschel siblings give each other a high five.

NARRATOR (CONT'D)
Today we use infrared light almost everyday. Bank notes and passports are checked under infrared light. Night vision devices use infrared light, too. We could not operate the remote control of our TVs without infrared light. Heating and some of our modern thermometers also work with infrared light. And...

The Narrator looks at the audience.

NARRATOR (CONT'D)
This discovery made it possible for scientists all over the world to build new telescopes with which they discover new phenomena. And so Herschel’s dream, the study of the Universe, lives on today.

THE END