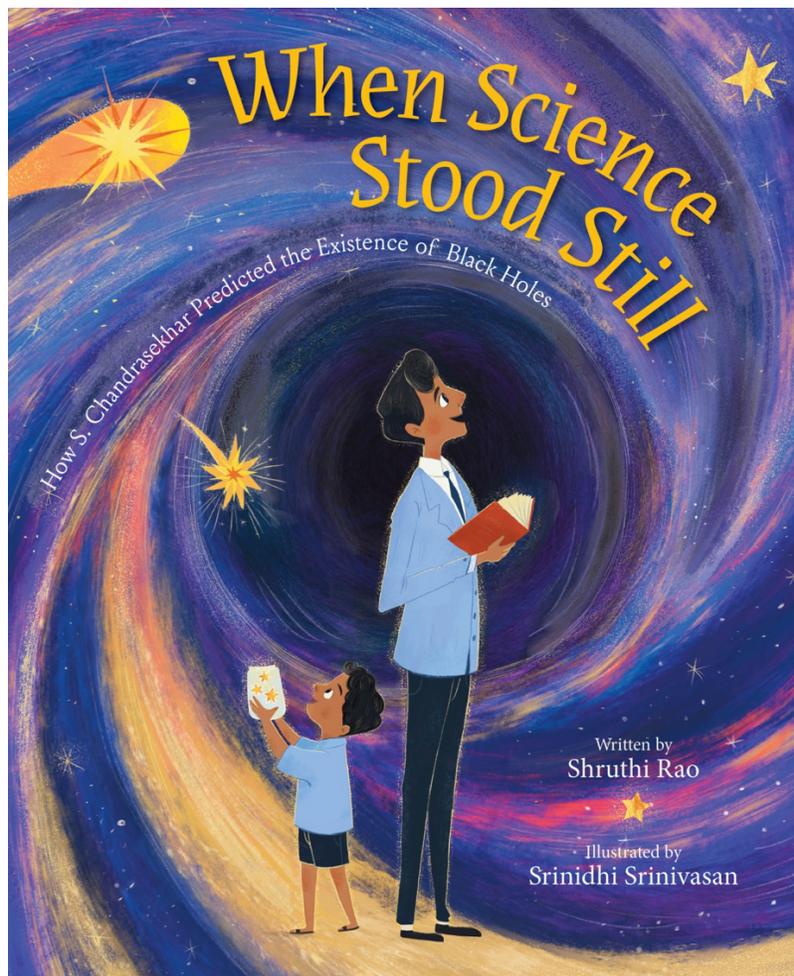


WHEN SCIENCE STOOD STILL

**How S. Chandrasekhar Predicted
the Existence of Black Holes**



Teacher's Guide prepared by Shruthi Rao
based on the picture book
written by Shruthi Rao, illustrated by Srinidhi Srinivasan
and published by McElderry Books/S&S

Shruthi Rao, Author

Shruthi Rao is the award-winning author of 20 books for children, both fiction and non-fiction, published in the US and India. She has a masters degree in energy engineering. Originally from India, she now lives in Northern California. She loves stories, science, benches, desserts and long walks.

Srinidhi Srinivasan, Illustrator

Srinidhi Srinivasan is an Indian children's book illustrator. Though she graduated with a bachelor's in computer science engineering, she realised that drawing and creating magical worlds were what tickled her heart. She loves telling diverse stories of vibrant characters who have their own say in the world. When she is not drawing, you can find her lost in a book or snuggling with her dog (Zurich) and scribbling in her sketchbook as her tea gets cold.

A note from the author

I've designed this brief classroom guide for **WHEN SCIENCE STOOD STILL: How S. Chandrasekhar Predicted the Existence of Black Holes** for students first to fifth grade. It contains questions, discussion points and conversation-starters. Please adapt them to suit your classroom and your students.

The book itself has extensive backmatter about the science of stars and black holes, so I haven't included that explanation in this guide for the sake of brevity.

If you or your students have any further questions, or if they want to share something with me, you're always welcome to write to me at shruthiraoauthor@gmail.com

You can also look for updates and additions to this guide, and guides for my other books as well, on my website (www.shruthi-rao.com)



Happy reading and discussing!

Shruthi Rao

Contents:

Table of Contents

Before Reading.....	5
Reading Comprehension	5
Social-Emotional Learning.....	6
Science and the Sharing of Ideas	7
Predictions and Discoveries using Math	8
Finding Connections between Different Fields	9
Finding Examples of Scientific Discoveries and Inventions	10
Language Arts	11
Writing Activity.....	12

Before Reading

Look at the cover and think about the title.

- Who are the two people on the cover? What are they doing?
- What else do you see on the cover? What do you think it means?
- Can you guess what the story is about?
- What does it mean for science to stand still?
- The subtitle says “Predicted the Existence of Black Holes”. To predict is to say that something will happen in the future. What do you think the author means by predicting the existence of black holes?

Reading Comprehension

- Where did Chandra live?
- What did Chandra like to do when he was a little boy?
- What is astrophysics?
- What happened on the way to England?
- How did this discovery make him feel?
- What was he looking forward to do in England?
- Who was the scientist who encouraged him at first?
- What was Chandra’s discovery?
- How did Chandra feel when scientists didn’t believe his ideas?
- Why didn’t they believe him?
- Why did Chandra decide to stop trying to convince people?
- What did Chandra do in America?
- What events led to people getting interested in the science of stars again?
- What was different this time?
- How was Chandra recognized for his discovery?

Social-Emotional Learning

- When scientists laughed at Chandra's ideas, he felt sad and betrayed. How did this make you feel when reading the story?
- Chandra decided to stop trying to convince people that he was right. Why do you think he did that? What would you have done in his place?
- If Chandra had continued the rest of his life trying to convince people that he was right, what do you think his life would have been like?
- Why do you think the scientist Arthur Eddington publicly rejected Chandra after initially supporting him?
- What qualities do you think Chandra had that helped him overcome rejection?
- What can we learn from this story about how to respond to criticism or rejection?
- What can we learn from Chandra about being patient?
- Chandra won the Nobel prize. But what mattered more to him than the award was that the world had finally seen the truth about the stars. Why do you think that was more important to him?
- What can Chandra's story teach us about being brave when sharing new ideas?
- Have you ever faced a situation where someone didn't believe what you said? What did you do then? Do you wish you had done something different?

Science and the Sharing of Ideas

- Chandra's very first major discovery was shot down by other scientists. They laughed at him. Yet, he continued working in science and sharing new discoveries with the world.
Why is it important to keep sharing your ideas?
- Why is it important to listen to new ideas?
- What may happen when a new idea is ignored without giving it enough thought?
- Why is it important to listen to all ideas and opinions, even if you don't agree with them?
- Why should we be careful about believing everything that we hear or read?
- Why is it important to check ideas with real evidence?
- Why do people sometimes reject facts, even when there is clear evidence?
- Can you think of a time when you learned something new that changed what you thought before?
- Proven science is science that has been tested, verified through evidence and large-scale research.
What might happen if society ignores proven science?

Predictions and Discoveries using Math

Chandra's mathematical calculations indicated to him that there must be a very strange object out there in space, though nobody knew that such an object even existed. This was later given a name – a black hole.

Chandra was able to use just math to calculate that such an object existed. Math can do many more wonderful and surprising things like that.

- Thousands of years ago, the scientist Eratosthenes calculated the size of the earth pretty accurately by measuring just shadows.
- The ancient Egyptians used math to predict when the River Nile would flood, and how much it would flood, so that they could plan their agricultural calendar.
- Scientists predicted the existence of the planet Neptune through math, even before it was discovered.

Math makes many such predictions possible!

Today, math is used to predict traffic, the weather, the spread of diseases, a country's economy, and many other things.

Have you ever used math or numbers or measurements to predict something?

Finding Connections between Different Fields

In science, innovations and discoveries in one field leads to discoveries in another.

- In this story, scientists researched about how bombs work – and that led to them thinking about how stars work.
- Understanding how the brain works has led to development of Artificial Intelligence
- Knowledge about space has led to better understanding of our earth and its climate.
- Innovations in chemistry has helped artists able to better protect and restore ancient works of art.
- AI technology designed to recognize pastries in Japanese bakeries is now being used to identify cancer cells in medicine!

Can you hunt for more examples like this in history and today?

Finding Examples of Scientific Discoveries and Inventions

The book begins with this passage:

*When scientists get things right,
science leaps forward.
When they get things wrong,
they learn from their mistakes,
and science still marches forward.
But sometimes,
even when scientists get it right,
nobody pays attention.*

*Then,
for a while,
science stands still.*

- “When scientists get things right, science leaps forward.”
An example for this statement: Scientist Alexander Fleming discovered penicillin, an antibiotic. This medicine has saved millions of lives. Other scientists learned from this, and discovered many more life-saving medicines.
- “When they get things wrong, they learn from their mistakes, and science still marches forward.”
An example for this statement: Inventor Thomas Edison tried hundreds of different kinds of light bulbs. Each time he failed, he knew what would NOT work. Finally, he found a version that did work.

Think of what you’ve learned about scientists, inventors and discoverers. Can you find examples for these statements from what you’ve learned about scientists, inventors and discoverers?

Language Arts

The author uses several figures of speech or literary devices in this story.

In the title, “When Science Stood Still,” the author uses **personification**.

Personification: Assigning a human quality to a nonhuman thing. Personification helps create a better connection with the subject, increases emotion, and makes things more interesting

Some more examples of personification from the book:

His pencil danced across a piece of paper, filling it with numbers. Finally, **the world saw** the truth.

Can you find more?

Another literary device used in the book is a **metaphor**.

A metaphor compares two unlike things by saying that one **is** the other. It is different from a **simile**, in which you compare two things by using “like” or “as”.

Example: “She is a dictionary” is a metaphor to describe someone who knows the meanings of a lot of words.

A simile would be “She is **like** a dictionary.”

An example from the book:

“Was it because **Eddington was such a brilliant star** in his field that they couldn’t even see the truth in his dazzling light?”

Can you find more?

Additional activity: In your next writing assignment, try and use personification, similes and metaphors.

Writing Activity

Imagine you are Chandra's friend. Chandra has just written a letter to you, telling you about how he has been laughed at for his ideas, and betrayed by someone he trusted. What will you write back in your letter to him?