

# Old Light Enables New Discoveries

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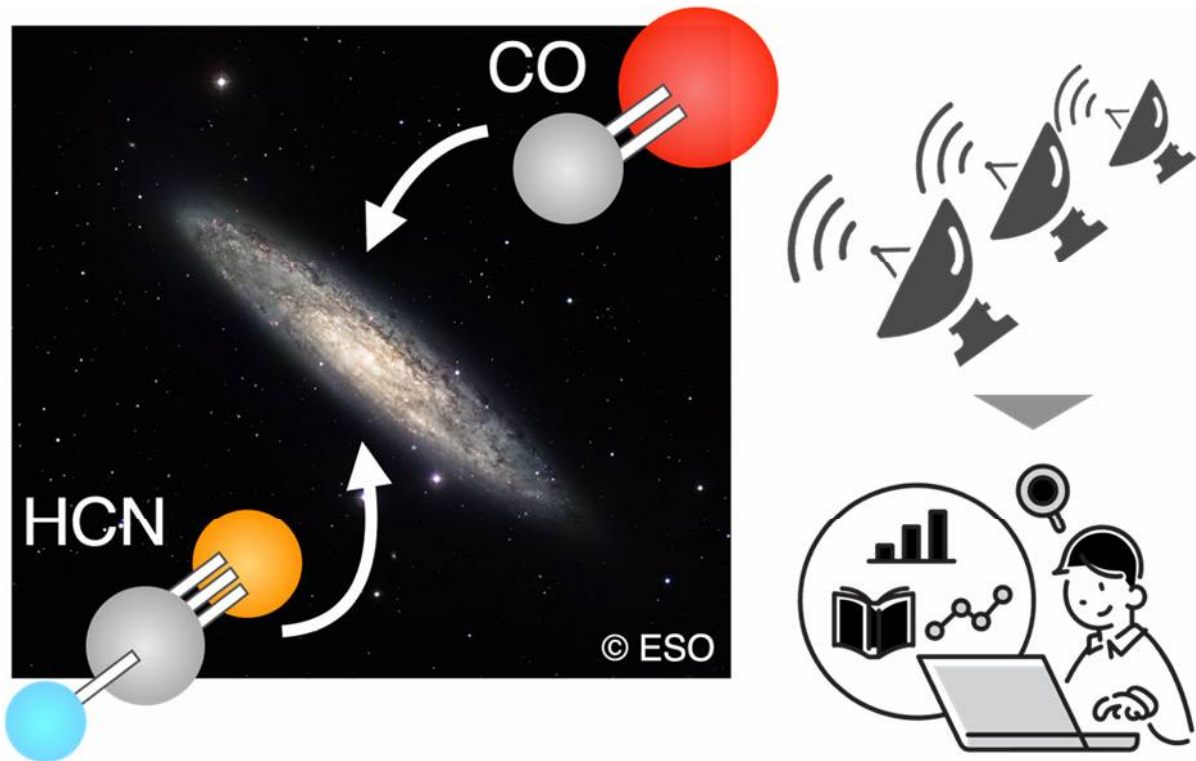


Figure 1. This figure illustrates how radio astronomers conduct their research. Many molecules, like carbon monoxide (CO) or hydrogen cyanide (HCN), are detected from a nearby galaxy radio telescopes. The chemical composition indicates the condition of that region. The original image is here (ESO - <http://www.eso.org/public/images/eso0902c/>)

## **Cosmic light as letters**

When you look up at the sky in the countryside without city lights, you can see a sky full of stars. You may notice the variety of colors, such as red, blue, and orange, in the stars. The light is like “letters” from the universe to us. People can learn about the history and properties of the past universe by reading the letters. Unfortunately, we don’t have a time machine, but we can use the light from galaxies. For example, if your friend sent a letter and you received it 2 days later, you can only know the content of the letter written 2 days prior. We can use the same scheme for the letters from the galaxies: light. When you receive the light from galaxies 10 billion light years away, you know the information about 10 billion light years away.

### ***Past research***

Much research reveals that the universe was born 13.8 billion years ago. The universe gradually expands, generating a large amount of matter. The matter gravitationally gathers and changes the shape into stars. The stars gravitationally bound to form galaxies. As an interesting topic, the universe 10 billion years ago generated nearly one hundred times more stars than the present universe! We call this era the **cosmic noon**, which is an important era for researching the history of the universe (Madau and Dickinson 2014<sup>[1]</sup>).

### ***My current research***

Currently, I do my research to solve the mystery: “Why did the universe produce a lot of stars during the cosmic noon and stop the star formation up to the present?” However, it is difficult to get a clear view of galaxies ten billion years ago directly, so I focus on the nearby **starburst galaxies**, which produce a massive amount of stars compared to our galaxy. This is because such starburst galaxies and galaxies 10 billion years ago are similar in terms of the massive star formation. Among many nearby galaxies, I have studied the nearby galaxy NGC253, whose distance is around one million light years. NGC253 is (astronomically) close and has a region of highly active star formation. We suppose this galaxy leaves some signs of when star formation was active. I want to find such a sign and solve the history of the universe.

I use various kinds of molecules with large radio telescopes to grasp the properties of the galaxies. Your body is composed of extremely tiny grains, which are called atoms. A **molecule** consists of multiple atoms that are connected. Why are molecules essential in star formation? The kind of molecules greatly varies depending on the state of the environment at the location. In other words, we can use molecules as the sign of the physical state. I’m researching the molecular composition in environments where stars actively form, as well as in environments where star formation is not active. We use the Atacama Large Millimeter/submillimeter Array (ALMA), which has the best view of the universe. The ALMA has found many kinds of molecular species. You may have seen the radio telescope, Nobeyama 45 m, come on to the movie

“Detective Conan” this year. The ALMA is also a similar telescope to the Nobeyama 45 m telescope.

***Advice for you (12 years old)***

I want to tell you what you should cherish in my experience so far. The most important point is to communicate with a lot of people and cherish each encounter, which is the once-in-a-lifetime chance (一期一会 in Japanese). Now, you belong to a tiny community of family and school.

Constructing relationships with others is not only fun but also a connection to the new world. In my experience, I joined a summer school program hosted by the National Astronomical Observatory of Japan (NAOJ), and implemented research related to my current research topic. I keep doing my research with some national or international people afterwards. I had the opportunity to write and publish our paper in a peer-reviewed journal. If I didn't join the summer school program, I would not be here because I still didn't know the research field before the summer student program.

I recommend you tackle everything, even if that is not interesting for you right now. Actually, I believe that trying what you don't know well enhances your skills and motivations. Once you achieve something, you can get a small amount of confidence. I know you have a sense of inferiority complex because you don't have something like a special skill. I'm sure that it is no problem even if you have no special skills at that time. I can do my favorite research in astronomy at the NAOJ. That's a wonderful thing for me, but there are many interesting things. It is also a good thing that you are obsessed with something else. I hope you find the best way and become someone who has a good influence on others. Good luck!

Reference:

[1] Madau, P., & Dickinson, M. 2014, ARA&A, 52, 415

Note:

I used ChatGPT and DeepL to make sentences and Grammarly to correct my grammatical mistakes (All free plans).