

# Citizen Science in Space

## 2- Contests of the most beautiful photos of science

There are 4 criteria for successful technology projects. They must be :

- 1- Irresistibly engaging
- 2- Elegantly Effective
- 3- Technologically ubiquitous 24/7
- 4- Involved in solving real-life problems

With a competition of the most beautiful photos of science, students pursue what they are passionate about science by using the devices they have at their disposal, whether they are in school or outside the school. They are encouraged to question, explore and excel. It is an easy project to organize and evaluate. It can be integrated into language classes, science classes or social studies.

For example, the super moon occurs when one sees that the full moon is at its closest point in its orbit around the Earth. It is seen here with visible light and also in infrared. That raises a lot of questions.

Our students spend a lot of time playing video games and watching television. Observing the moon allows students to get a little closer to nature and get attached to it.

### **3- Earth Hour**

Because of light pollution, in the big cities, we do not see much of the sky. So, every year, at our school, we accompany our Grades 5 and 6 students on a 3-day expedition to Mansfield, 1 hour from Toronto to cross-country skiing and see the starry sky, far away from light pollution. Many students see the Milky Way for the very first time. If this is not possible, you can see the starry sky in March during Earth Hour when the whole city turns off the lights for an hour. This symbolic gesture, during Earth Hour, will show your support for the fight against climate change, saving a lot of energy.

**4-** It is possible to see the Earth at all times from the International Space Station. Here we see the Great Lakes and the aurora borealis over Quebec.

Would you like to go on a space trip? Guy Laliberté, this acrobat from Cirque du Soleil, has already done so. With the photos he took from space, he inspires people to give access to water to a million people in the world who do not have access to clean water.

### **5- Livecam**

There are live public cameras all over the world that can be used with any good device and the Internet. You can study the aurora borealis. With such dramatic phenomena, who would not want to make mathematical drawings with Hopscotch?

### **6- Women of science**

Who among you saw live astronauts set foot on the moon? I saw them live on television. This really inspires young people to pursue big dreams, even when many people discourage us. Donald Trump wants to go to Mars with an inhabited capsule and he is looking for people to help him. In Canada, we are well placed in the space industry.

The Minister of Education and Ivanka Trump encourage teachers to show the film 'Hidden figures' in the classroom. It is a historical film. They remind us that programming is the language of the future.

At the beginning of NASA's space program, computers wore skirts. The film shows us the struggle of brilliant women who manage to go beyond the glass ceiling to make a significant contribution to the mathematics and engineering of NASA's space program.

Today, with only 25% of women in engineering, this gap is still to be filled.

## **7- Making Connections**

The Star Walk app is quite exceptional for making reading links. By using the location, and moving its device, we can see the stars that are in front of us. If we move our camera, we see the stars that are in this different direction. By pressing on the bright point you see, one can obtain in direct time the information on what one sees. Star Walk is used to identify constellations, solar system objects, stars, and even satellites. Star Walk will also send notifications of the phenomena to be observed in the sky of the day.

## **8- Manipulation of basic concepts**

When using only images on paper, students develop many misunderstandings because one image does not fully explain spatial concepts. You can do simulations with pocket lamps and balls, or you can use edumedia. What's the difference if you play basketball on Earth, on the moon and on a comet? If you jump, you see the difference in the three places; The gravity is different. The Earth has the greatest gravity, it falls immediately after a fraction of a second. On the moon, gravity is much less. With the same effort, you could jump 6 times higher, a "slam dunk" would be much easier. On a comet, if you jump, you will find yourself very far.

## **9 - Chris Hadfield**

I know that Quebec's David St-Jacques will be the next astronaut to go to the International Space Station. Canadian astronauts are a constant source of inspiration for students. We only had to mention the space walk of Chris Hadfield so that the students spend hours following his work, his experiences and his exits in the space. The students wrote scientific blogs with Kidblog on Chris Hadfield. For example, the Canadian Space Agency has begun the BP reg experiment to study the vascular system of astronauts in space in weightlessness, which would help to find out why some astronauts vanish back to Earth. In space, the cardiovascular system is unconditioned because it has less resistance to gravity to pump blood into the body. In microgravity, the blood flows abundantly to the head and chest, which reduces the work of the heart. Returning to Earth, blood flows more into the limbs and less into the brain, causing the astronauts to faint. This experience also makes it possible to predict who will faint among the elderly, back on Earth.

## **10- c elegans**

Roberta Bondar is the first Canadian to travel to space. Since her childhood, she has always wanted to be an astronaut. She has a PhD in medicine and was teaching at the University when she applied to NASA to become an astronaut. Aboard the space shuttle, she made 193 hours in space and was responsible for several scientific experiments. She studied the growth of plants in space, diseases in space. She supervised 42 experiments on her Shuttle trip.

To help astronauts make their experiments, classroom students measure with the computer the size of c elegans worms, used in spatial agriculture.

## **11- tomatosphere**

The tomatosphere program uses the tomato seeds of space to study the effects of the spatial environment on their germination. We teach the processes of scientific research. We can also make connections with the mathematics program. Resources for these experiments can be obtained from the Canadian Space Agency. Marc Garneau is the first astronaut who brought tomato seeds into space for school studies.

## **12- Dave Williams**

Astronaut Dave Williams came to STAO Science Conference in Toronto. When he was younger when he considered the job of astronauts, several people discouraged him, showing him that only Americans went into space, that this profession was not open to Canadians. He did not understand why this should be the case and still continued his studies to become an astronaut. He was able to pursue his dream and visit the International Space Station in 2007. Dr. Dave Williams published the first in a series of four children's books on space exploration to educate children about The Canadian contribution to space exploration.

You do not know what to do during HourOfCode? You can use Hopscotch videos with the ideas from Dr. Dave's book. With Emoji Draw of Hopscotch, we show the science behind digestion in space, as learned in Dr. Dave's book. It is not advisable to burp in space, the risk being very great. In space, where there is no gravity, the air is also distributed with the food in the stomach. If you burp, you cannot predict what will come out, you could just see a little air or all the contents of his stomach!

One can also create a game with Geometry Dash where Dr. Dave must avoid space debris while walking in space.

**13-** Here we see the Canadian arm, the International Space Station, an astronaut in space and a reflection of the Earth during the space exit. This image was taken in real time with the NASA Web Cam during the Christmas holidays.

## **14- Peggy Whitson**

Peggy Whitson went for a space walk in early January 2017, the first woman to command the International Space Station. This inspires many journalists and budding journalists who write reports of everything so. Writers use Wattpad to publish their stories. Books published on Wattpad have been published because of their popularity. Wattpad is now a partner with researchers in the field of cinema. Some of these stories will be published on the big screen.

## **15- Citizen Science**

If one thinks of traveling in space in a more or less remote future, needs to know our universe. Scientists have a lot of work and are asking citizens to help them. It is citizen science or participatory science. The Galaxy Zoo website asks our students to classify the galaxies according to their form or the special attributes they may have. If we find a surprising galaxy, we can study it more deeply. Julie Payette recently spoke on the show *Découverte*.

## **16- Artificial Intelligence - Supervised Learning**

If one pushes Julie Payette's lesson a little further, to inspire our budding computer scientists and engineers, one realizes that one can make artificial intelligence. The AI will be able to identify the galaxies, their type and whether more attention should be paid to them with a 90% confidence level. To do this, AI must learn to see and interpret images. Supervised learning is like showing a child a picture book. We show an image and we say it is a galaxy. We show another image, is it a galaxy or not? After a few images, the AI realizes what a galaxy is.

## **17- Artificial intelligence - deep learning**

To predict whether one should pay more attention to a galaxy, one must find abnormal pixels among regular images. Deep learning allows images to be represented. The higher the level of representation of these images, the more the artificial intelligence will be able to interpret what it sees. For example, in the constellation of the coachman, there is a galaxy that keeps flashing.

## **18- Including girls**

The image that students have of science and scientists affects their interests and their motivation in the study of science. Their motivation is an important element in their level of scientific literacy. It is important to include the contribution of cultures from around the world in order to introduce all our students to scientific culture.

In the Middle East and even today in North America, the field of science and engineering is dominated by men. Few women occupy the positions of professor at the university. In order to encourage girls to consider this field, I break the status quo and I insert in the historical image of female scientists who move in the observatory at the touch of the finger on the iPad.

## **19- Cassini's final mission**

Last April, the spacecraft Cassini began a bold series of orbits, Cassini's final mission, coded here with Hopscotch. The spacecraft will climb several times over the northern pole of Saturn. Cassini will survey the active geysers of the Enceladus moon, and then dive between the planet and the inner ring 22 times to finally crash into Saturn. A timely interesting project to do in June or September.

## **20- Observing the sun safely**

Scientists come to school or can be seen at the Ontario Science Museum. One can point a telescope during the day towards the sun. There are filters that allow you to watch the sun safely. You can even take pictures. If you are a member of the Royal Astronomical Society of Canada, we will even lend you a telescope at no cost for two weeks to do astronomy. This would allow you to see the eclipse of the sun next summer.

We wondered if Tatooine of Star Wars could really exist. NASA has actually found Kepler 453b in the constellation of the Lyre. It is in a habitable zone and orbit around two stars: a red dwarf and a sun. Using the photos of our sun, we simulate this discovery of NASA with Hopscotch.

## **21- Observing the sun safely**

You can also watch the sun safely with an infrared camera that is attached to our iPad. I look forward to using it to see the eclipse next summer visible from North America. We can also do a simulation of the eclipse with Hopscotch.

## **22- Hubble Space Telescope**

The Hubble Space Telescope is the most powerful telescope we have today. It was put into orbit in 1990 by the Discovery shuttle. It was kept in space by the astronauts. We had to put on glasses to see more clearly. The telescope still works, but if it breaks, there is no more shuttle to repair it.

The Hubble telescope took the name of the great astronomer Edwin Hubble.

## **23- Hubble's Law**

The Hubble telescope took the name of the great astronomer Edwin Hubble. Edwin Hubble is known to have demonstrated the existence of galaxies outside of our Milky Way and the Hubble theory, a major theory explaining the expansion of the universe. According to Hubble, light spreads like an expanding bubble. Double the distance and the bubble has a surface 4 times larger.

## **24- Radical idea of the expansion of the universe**

In her book 'Mapping the Heavens', the astrophysicist Dr. Natarajan of Yale University traces the development of radical scientific ideas that have changed our conception of the universe. Reactions to these radical new ideas have often caused a revision of our deepest beliefs. Towards the 1930s, even though Einstein and Eddington supported the theory of the expansion of the universe, Hubble, who had discovered the law with his research despite all the scientific evidence, remained septic and did not believe in the Expansion of the universe. You see, the theory of the stable model of the universe represented the atheist vision and the theory of the expanding universe represented the theistic view. In 1952, Pope Pius XII the idea of the Big Bang because it supports the idea of a Creator of the universe.



## 25- The radical idea of black holes

A black hole is in the centre of almost all galaxies. It devours all matter and light within the reach of its irresistible field of gravity. Einstein's theory of general relativity allowed the understanding of black holes, but Einstein did not believe in their existence. Nor did Eddington believe in the possibility of a black hole. One of his students, Chandra did all the calculations demonstrating their existence but it was publicly obliterated by Eddington. Chandra persisted and in 1983, he won Nobel Prize for his theory and calculations. A scientist from the University of Toronto, Tom Bolton, saw a black hole for the first time with the David Dunlap Observatory in 1971.

## 26- SDSS

Here are some images of the Spatial Hubble telescope, our most powerful telescope. One can see in the Sloan Digital Sky Survey, for example, a catalogue of galaxies that can be seen from the back of our house. For example,

**M87**, the largest galaxy.

**M101**, the most common.

**LMC**, 1000 times smaller.

27- The James Webb Telescope is under construction and almost ready to be deployed in space. It will allow us to continue to answer these multi-generational questions: How did the universe begin? And are we alone in the universe?

The astrophysicist Adam Muzzin from York University will be one the Canadian scientist who will use the James Webb Telescope to observe the very beginning of the universe.

## 28- James Webb Space Telescope

The cost of the James Webb Space Telescope is \$ 9 billion. The mirror is about the size of a tennis court. The white part is the thermal shield of the telescope that protects it from the sun. This telescope will only work with infrared. It is too big to be placed in the biggest rocket. It will be necessary to send the parts in several launches of rockets and to assemble it in the space. It will be placed in orbit at 1 501 517 km from Earth. The deployment will last 1 month. It was built to last at least 5 years.

The light travels at a constant speed. If the light takes 100 years to reach us, we see 100 years back.

**29.** We now see, with the Hubble telescope, the majority of the stars. They are between 8 and 10 billion years in the past.

**30-** With the James Webb telescope, we want to see the first 0.001% of the formation of the stars. ---- Look where the pink arrow is, at the distance redshift = 11.135- Galaxie GN-11

### **31- GN-11 Galaxy**

It is the place where one can see the most distant galaxy with the Hubble telescope. It takes a full day to see it. It's just a fuzzy form. We have no trouble seeing her. Dr. Adam Muzzin said that for the press release, astrophysicists do like Trump, they dress up the picture well.

**32-** What astrophysicists saw with Hubble looks more like this. The image was reproduced with Hopscotch. The James Webb telescope will be 100 times more powerful than Hubble.

### **33- The radical idea of the Millennium Simulation**

It is the simplest and most detailed simulation of the Universe. The simulation traces the evolution of the large-scale structure of the universe.

It is the computers with superior graphic capabilities that make it possible to visualize cosmic objects and make comparisons with astronomical observations. Simulations become substitutes for experiments. Simulations are no longer just a tool to test our ideas, but a new and powerful method of creating new knowledge.

**34-** The region of space (at the orange arrow) is called inflation. It is in this region of space where we look to understand the beginnings of our universe, the big bang, 14 billion years ago.

### **35- South Pole Telescope**

The astrophysicist Dr. Tyler Natoli of the University of Toronto participated in the construction of the South Pole Telescope, collecting and analyzing its data. Observation in Antarctica has advantages since it is night 6 months a year and it is in very high altitude. It shows the same stars 24/7/52. With the cold, the air is really very dry because the water does not evaporate. The atmosphere is stable because there is no sunrise and sunset that stirs the particles into the atmosphere. When the radiation touches the bolometer detector, it records the temperature differences on the detector. The images obtained are passed through computer filters to obtain the image on the right. It is a picture of the universe 380,000 years after the Big Bang, in the first 3% of the formation of the Universe.

### **36 -See the 380,000 Years After the Big Bang**

In the primordial universe, at 6,000 Kelvin, we can see particles, protons and neutrons. After some time, the temperature cools to 3000 K, allowing the particles to assemble and form atoms. With the cooling, one also sees the light which generally goes in a straight line, except when it meets particles that reflect the light.

### **37- The Inflation Theory**

It is Dr. Andrei Linde of Stanford University who is at the origin of the theory of inflation. He spoke with Al-Jazeera. He is worried about the students' scientific and mathematical knowledge. He says that if we use old books, old methods, we will do a good job but not an excellent job. Discoveries, innovation will only happen when we do an excellent job.

### **38- Finding a second Earth is just a matter of time**

Last February, Dr. Michael Gillon from Liège University made a press conference at NASA about his discovery of 7 rocky planets circling TRAPPIST-1 a mere 39 light years away within the Milky Way galaxy. It is a record for the greatest number of habitable-zone planets found around a single star. That is 7 planets with Earth-like temperatures orbiting the star TRAPPIST-1. Dr. Gillon measurements were precise enough to suggest water-rich composition. Only the James-Webb telescope will be able to definitely measure the presence of water or methane on those distant planets. If oxygen is detected, we could see the possibility of plant life. Finding a second Earth is not a matter of IF but a matter of WHEN.

### 39- Quality of sources of information

One often wonders if there are extraterrestrial on Earth. Which sources of information are the most credible? We have a discussion with Padlet. YES, extraterrestrials exist. They are in every space movies. Another said YES, they exist on Earth, look, I took a picture of the extraterrestrial in infrared. Someone else says YES, TVA talks about it, it seems plausible. Julie Payette at Discovery Radio-Canada says NO. The extraterrestrials are not on Earth, she has never seen them. John Percy, a University of Toronto astronomer, says there are no astronomers on Earth but he would like them to come to campus. Adam Muzzin from York University points to TRAPPIST and tells us that if we want to find life, TRAPPIST is the system to do it in. Which sources of information to believe? By discussing all the angles of an issue using several types of technology, and several sources of information, we are working at the redefinition level of the SAMR model.

40- Hopscotch provides videos to help you write the code for numerical simulations of the universe. I also wrote this book to help you. You can access it on my Twitter account.

41- The media are filled with troubling stories. We live in a world where fear, hatred prevail over rational thinking. If you were a school principal, would you hire someone who refuses to improve her practice? I think this is the time to use an emotional intelligence strategy and take a step back, to reflect, in order to see the world on a larger scale.

Despite major floods, you can see to the left what I like to do in my backyard. I like to spend a lot of time outdoors and stay close to nature. Maybe I have this from my great-grandmother Boulanger. She lived for 101 years at the General Store in Notre-Dame-des-Bois, at the foot of Mont-Mégantic. There is now an observatory at the top of Mont-Mégantic in the first international reserve of starry skies in the Eastern Townships.

By seeing the world on a larger scale, we may be able to realize that we are all citizens of the universe.

### 42- citation

"We make our world meaningful by the courage of our questions and the depth of our answers." - Carl Sagan