

恒星的派对

Stars give parties

Rosa M. Ros and Beatriz García

International Astronomical Union

Polytechnical University of Catalonia, Spain

ITeDA and National Technological University, Argentina

国际天文联合会

加泰罗尼亚理工大学，西班牙

国家科技大学，阿根廷



Justification

前言

- This material is designed for teachers of children before starting primary school. Some content is presented to give the teacher more resources, although they may be too ambitious for such young children, but the questions that they may sometimes ask require more extensive knowledge to be able to properly explain the issues that may arise.
- 本教材是为学龄前儿童教师设计的。有些内容的呈现是为了给教师提供更多的资源。虽然这部分内容对学龄前儿童来说有些难，但是教师需要更广泛的背景知识才能恰当地给儿童解释他们提出的一些问题。



Goals

教学目标

- Understanding stellar evolution.
- 了解恒星演化
- Understand the different types of stars.
- 了解恒星的不同类型
- Understand the appearance of the heaviest materials inside stars
- 了解恒星内部重元素的出现



Method

教学方法

- The Matyllda story is used, which must be adapted to the age of the students.
- 使用马蒂尔达的故事，故事必须进行改编以适合学生的年龄
- The narrative includes concepts about the birth, development and end of the stars, as well as the formation of the elements necessary for life.
- 故事包含恒星的诞生、演化和死亡，以及生命必需元素的形成
- The following slides **highlight the paragraphs of the story with scientific concepts.**
- 下面的幻灯片对故事中包含科学内容的片段进行了标黄
- Before starting the session with the ppt, it is advisable that the participants read the story with enough time.
- 在开始PPT部分之前，建议参与者充分阅读故事内容。



Once upon a time a bright and
luminous cloud... of interstellar gas

and dust...was found between the stars.

很久很久以前，在恒星中发现一片明亮发光的
云，它是由星际气体和尘埃组成。

It was a hot cloud... because the dust
particles that formed it were organizing

a party and were running around

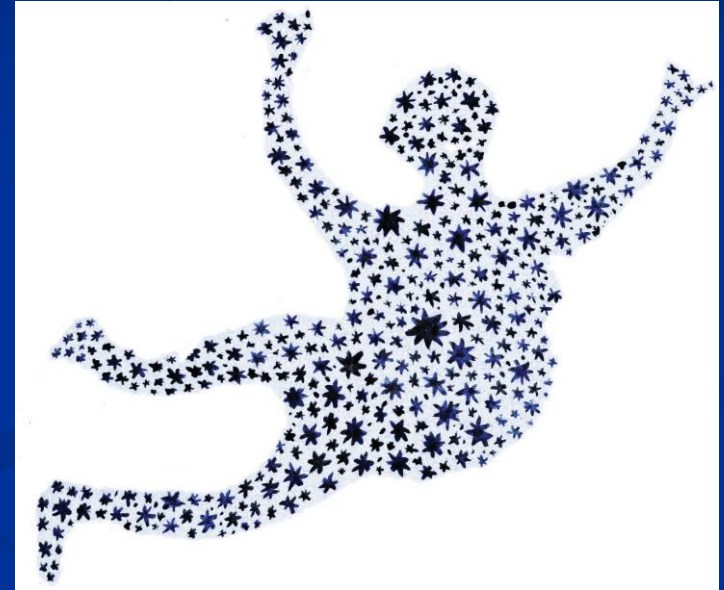
playing... between the crashes that

occurred and all the running... the
atmosphere became increasingly hotter

and hotter.

那是一片很热的云，因为组成它的尘埃粒子在
举行一场派对，正跑来跑去地玩...由于粒子不

断发生碰撞并且到处跑来跑去，于是气体云变
得越来越热。



... **stars** are similar to children, they **form in** their mother's belly, **the cloud of interstellar gas and dust**, and then they are born and grow, and become older. But since the clouds of bright gas and dust are very large, instead of 1, 2 or 3 stars being born, as happens with children, hundreds of stars **are born at the same time...**

恒星和我们人类的孩子很像，也**孕育于**它们母亲的肚子——**星际气体和尘埃云**，然后它们就诞生，成长，并**逐渐变老**。但是由于明亮的气体和尘埃云是非常巨大的，因此与我们人类的孩子一次只出生一个、两个或三个这样的方式不同，数以百计的恒星是**在同一时间一起诞生的**。

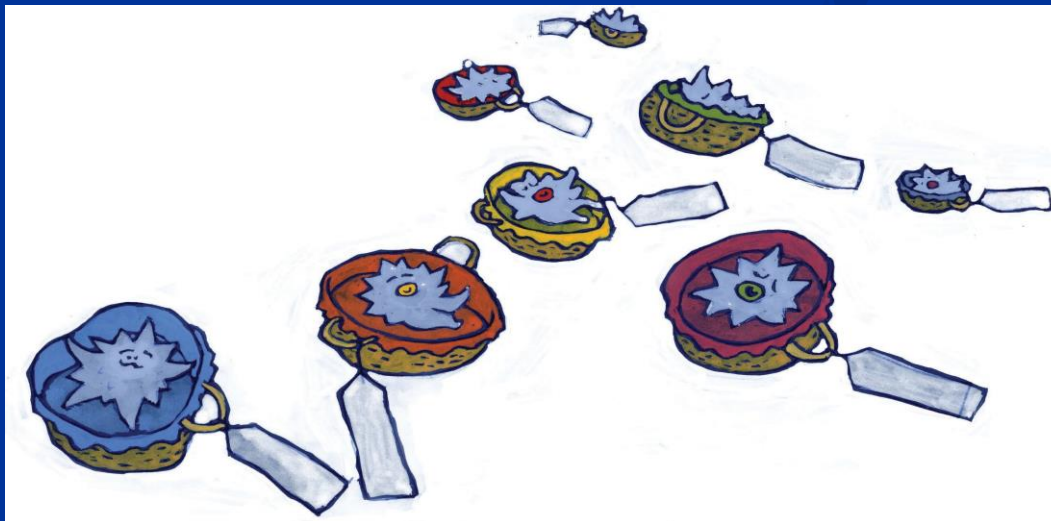


...the particles and specks of dust have been running for thousands of years, **and after many collisions and agitation they remain embraced and so stuck to each other that little by little they form stars.**

The party ends when these stars begin to be born, but the truth is that they take hundreds of thousands of years to fully form....

这些尘埃粒子已经运动了数千年，并且**经过许多次地碰撞和搅拌后**，它们仍**旧一直紧紧地拥抱在一起**，并一点一点地形成了恒星。

当这些恒星开始诞生时，派对就结束了。但事实上，恒星的完全诞生需要数十万年的时间。



Some of these **bright and beautiful reddish clouds, mothers of so many stars, can be seen in the sky at night.**

在夜晚的天空中，可以看到一些明亮而美丽的微微发红的云，它们是很多恒星的母亲。

In the cloud of our story there were 683 stars, all of them sisters and daughters of the same mother.

在我们故事的这片云中，共有683颗恒星，它们都是姐妹，是同一个母亲的女儿。



Not all the stars are the same, but we are going to follow the life of one of them...she herself has already decided what her name is going to be: Matyllda with “Y”.

并非所有的恒星都是一样的，但我们将跟随其中一颗恒星的生活.....她自己已经决定了她的名字：带“Y”的玛蒂尔达。

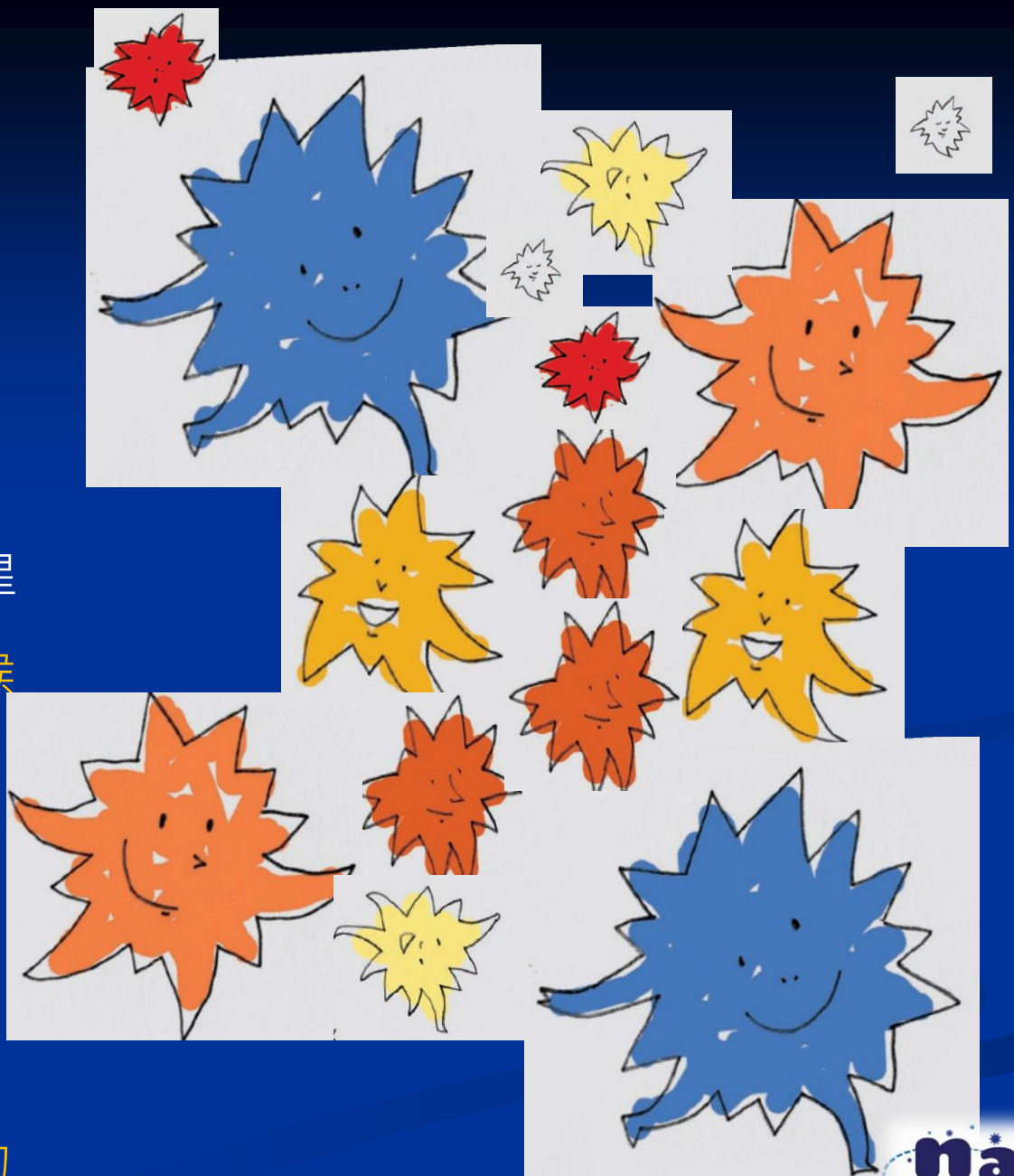


I am a yellowish white star. Stars have different colors that depend on the temperature. **The hottest and largest are born in blue or white colors.**

我是一颗黄白色的恒星。恒星因为温度不同有不同的颜色。最热和最大的恒星出生的时候是蓝色或者白色。

If we are more **normal and average like me**, we are born somewhat colder and yellow in color.

如果是像我一样正常和普通的恒星，一般诞生时温度会低一些，颜色是黄色。

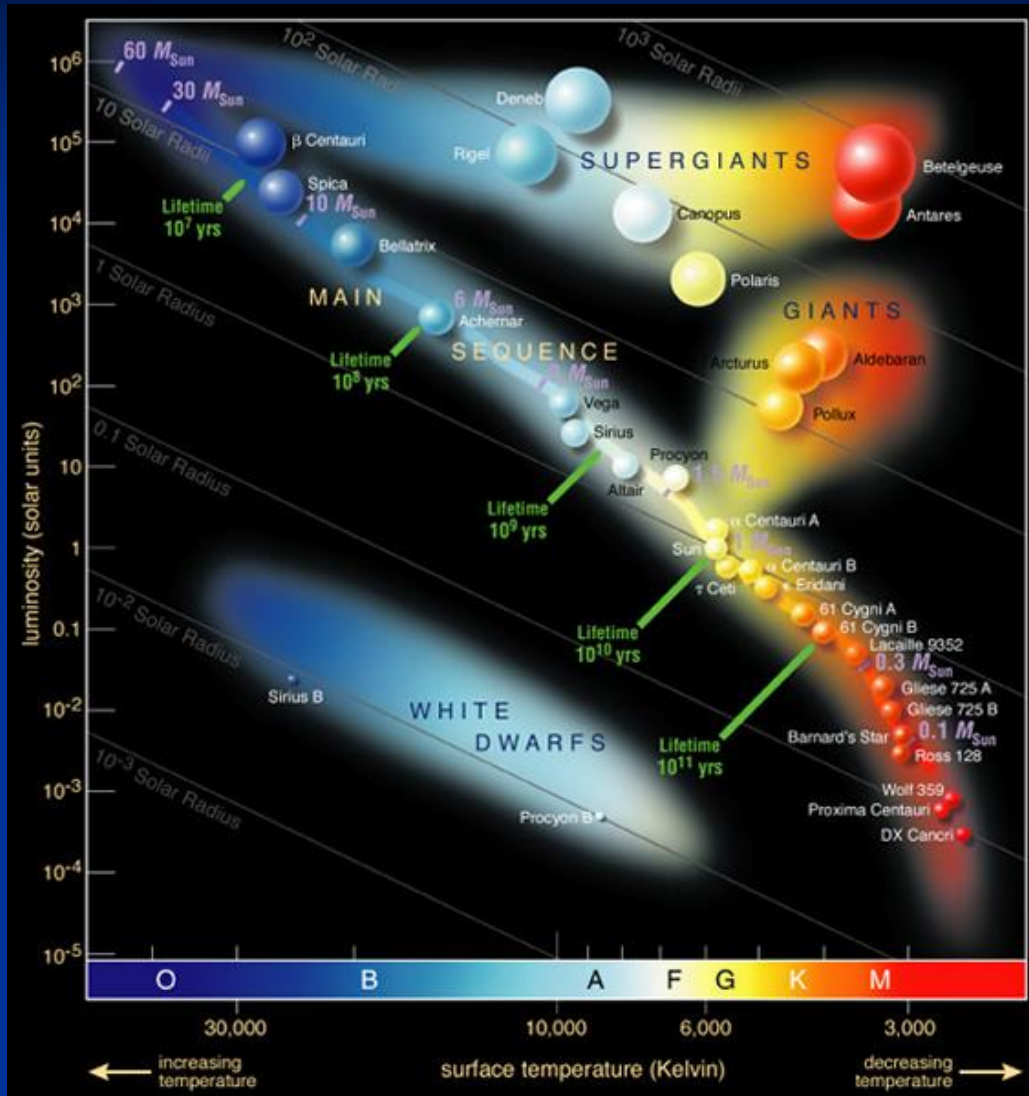


Hertzsprung-Russel Diagram
赫罗图



Activity 1: HR Diagram model

活动1：赫罗图模型



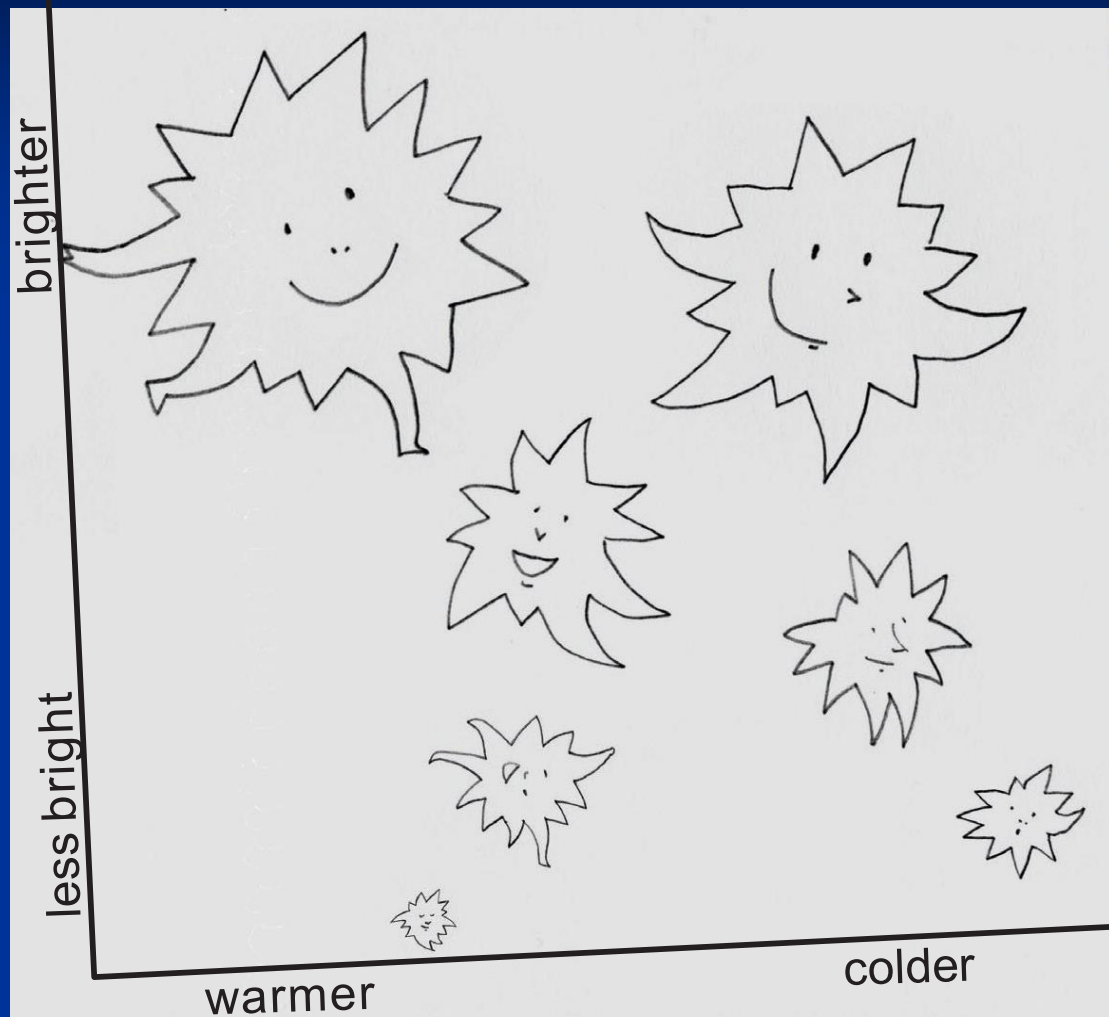
Hertzsprung Russell
Diagram
to summarize stellar
evolution
总结恒星演化的赫罗图

(Credit: Enrique F Borja)



Activity 1: HR Diagram model

活动1：赫罗图模型



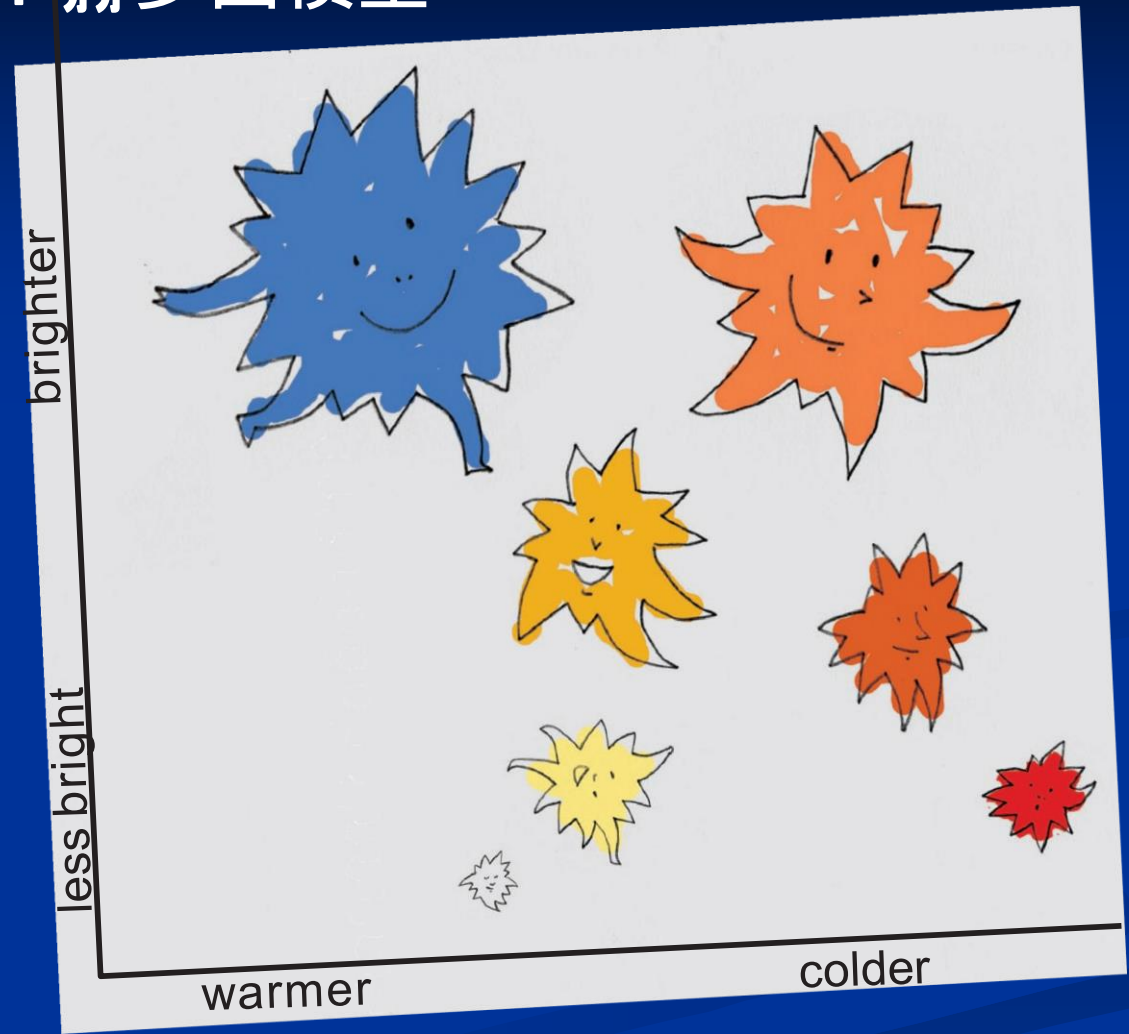
HR Diagram to
color following
Matylda's story

根据马蒂尔达的故
事给赫罗图涂色

Activity 1: HR Diagram model

活动1：赫罗图模型

HR Diagram
colored solution
赫罗图涂色方案



Hertzsprung-Russel Diagram

赫罗图

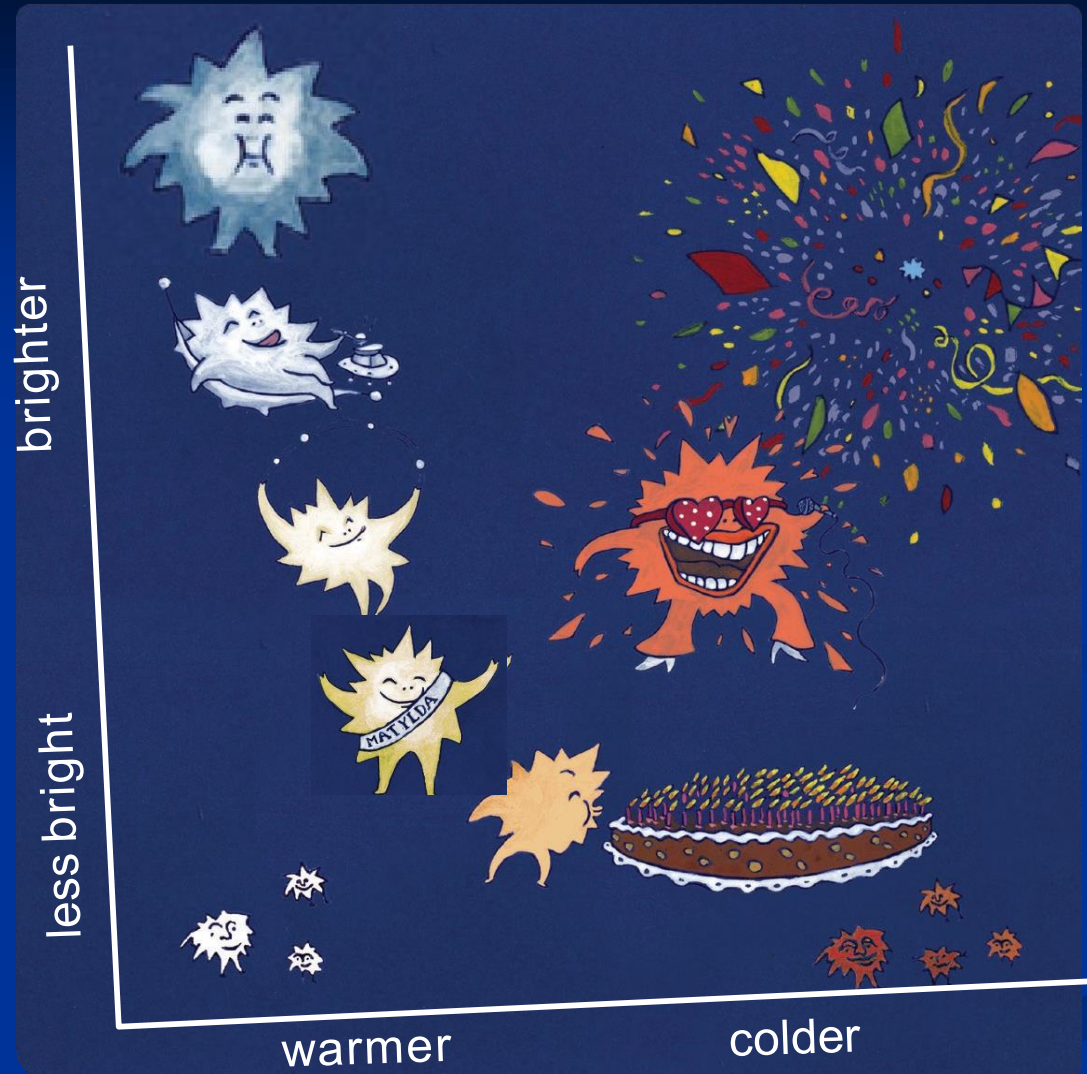


Almost all of our lives, we stars are quietly eating hydrogen and creating other heavier materials inside us.

几乎在我们的一生中，我们这些恒星都在悄悄地吞噬着氢，并在体内创造出其他更重的物质。

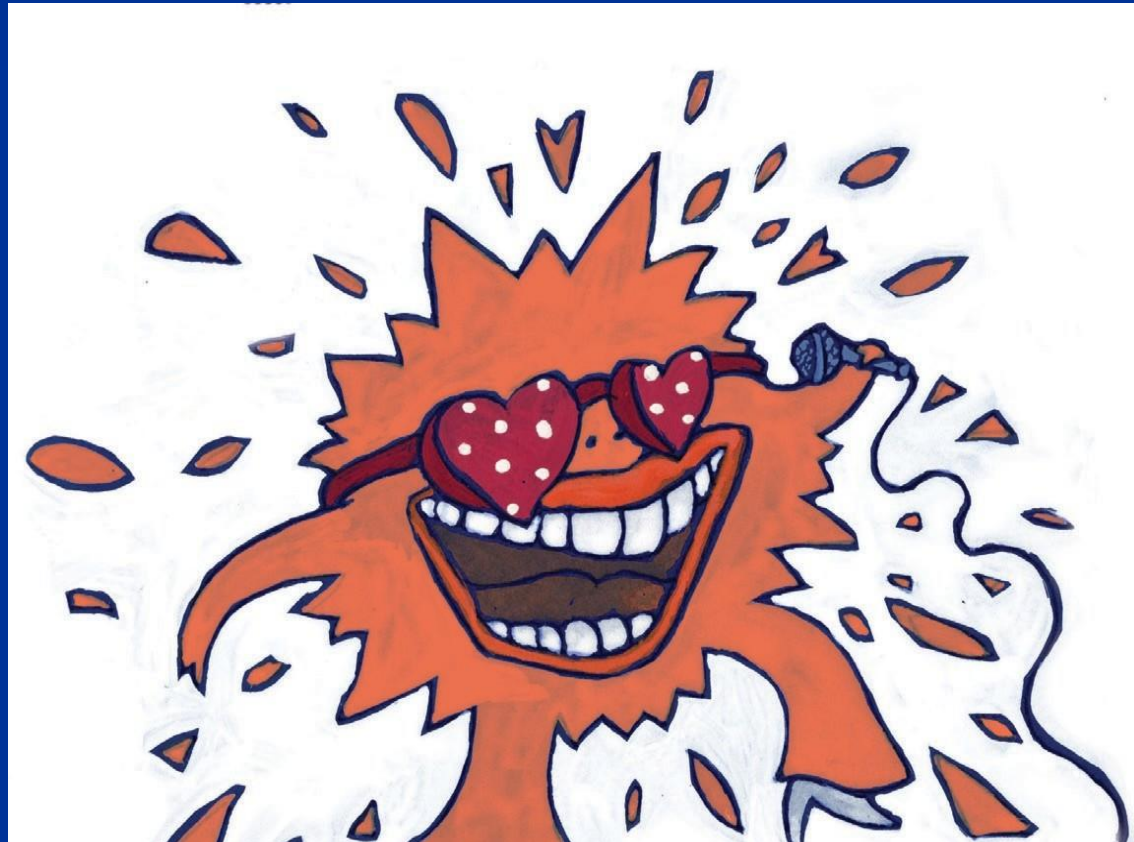
It's a great life.
They call that being in the “main sequence.”

这是一种美好的生活。以这种方式生活的恒星被称为处于“主序列”的恒星。



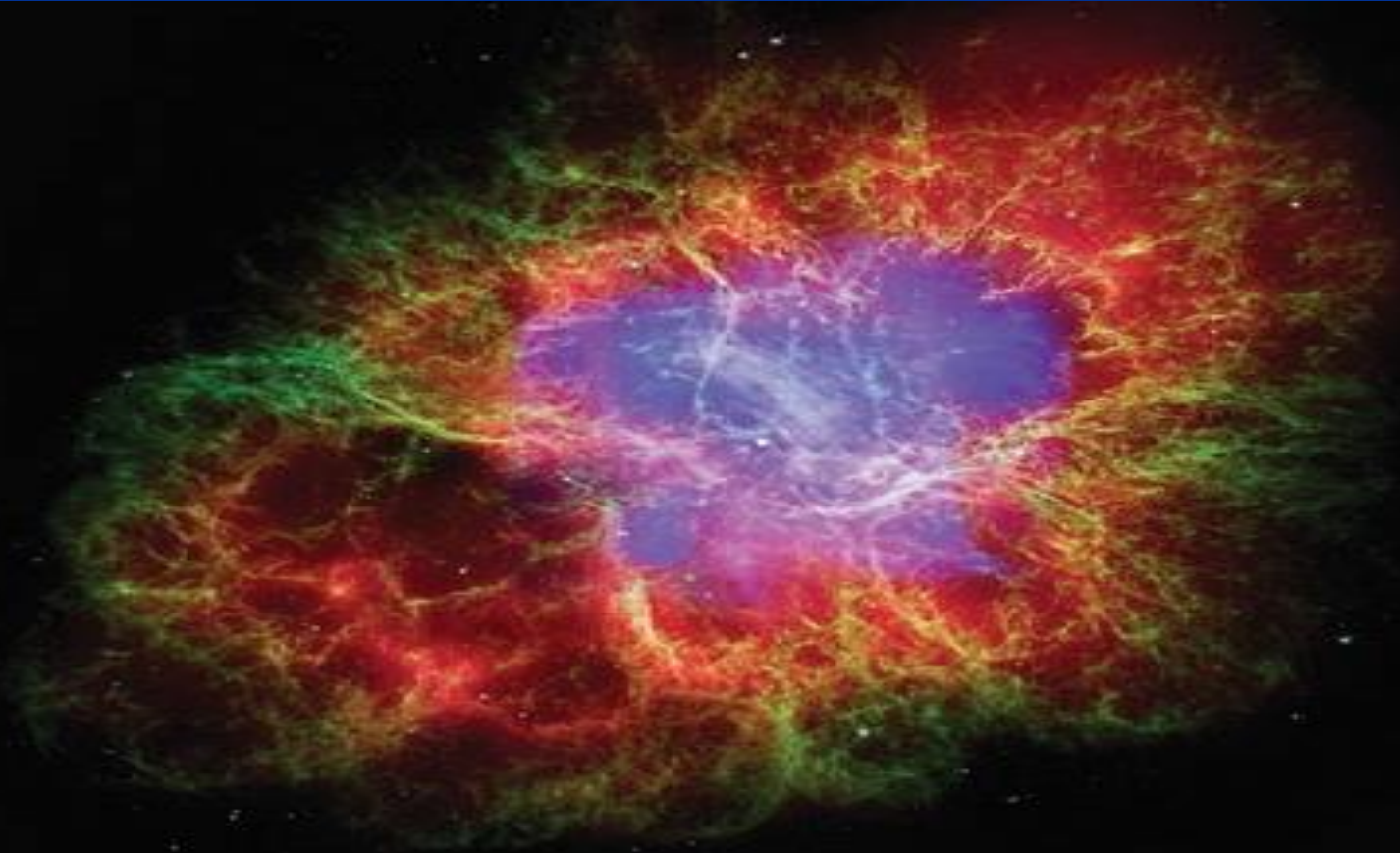
Later, when I have eaten almost all my hydrogen.... I will prepare to organize my big party.... with a lot of stress...with stress we swell and become huge and we get cold and become red.

之后，当我几乎吞噬掉体内所有的氢的时候....我将会去举办一个盛大的派对....有着很大很大的压力....在压力的作用下，我们不断膨胀，然后变得巨大，并且慢慢变冷，变红。



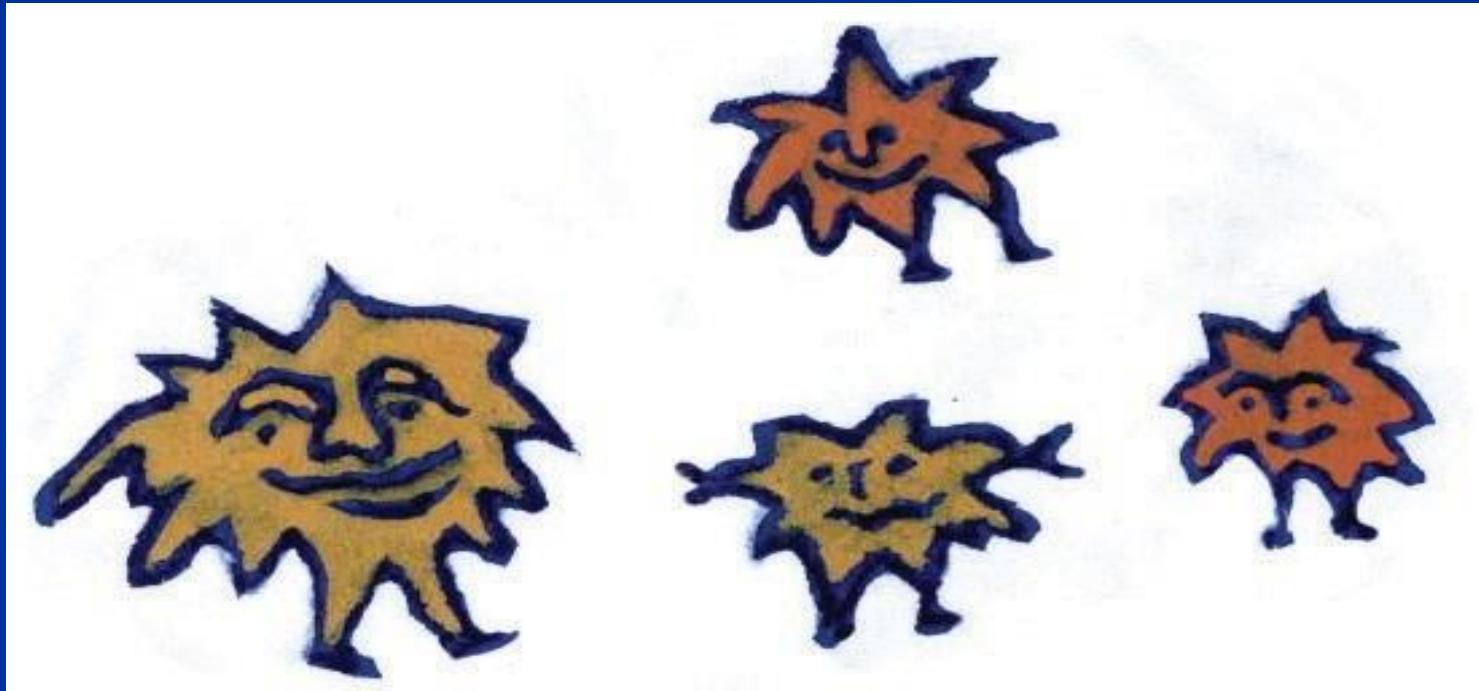
The smallest stars live many more years than the largest ones, which live less, just as gossip says, “the big ones live fast”, but yes, when they are older they “swell up” like red supergiants and throw incredible supernova parties.

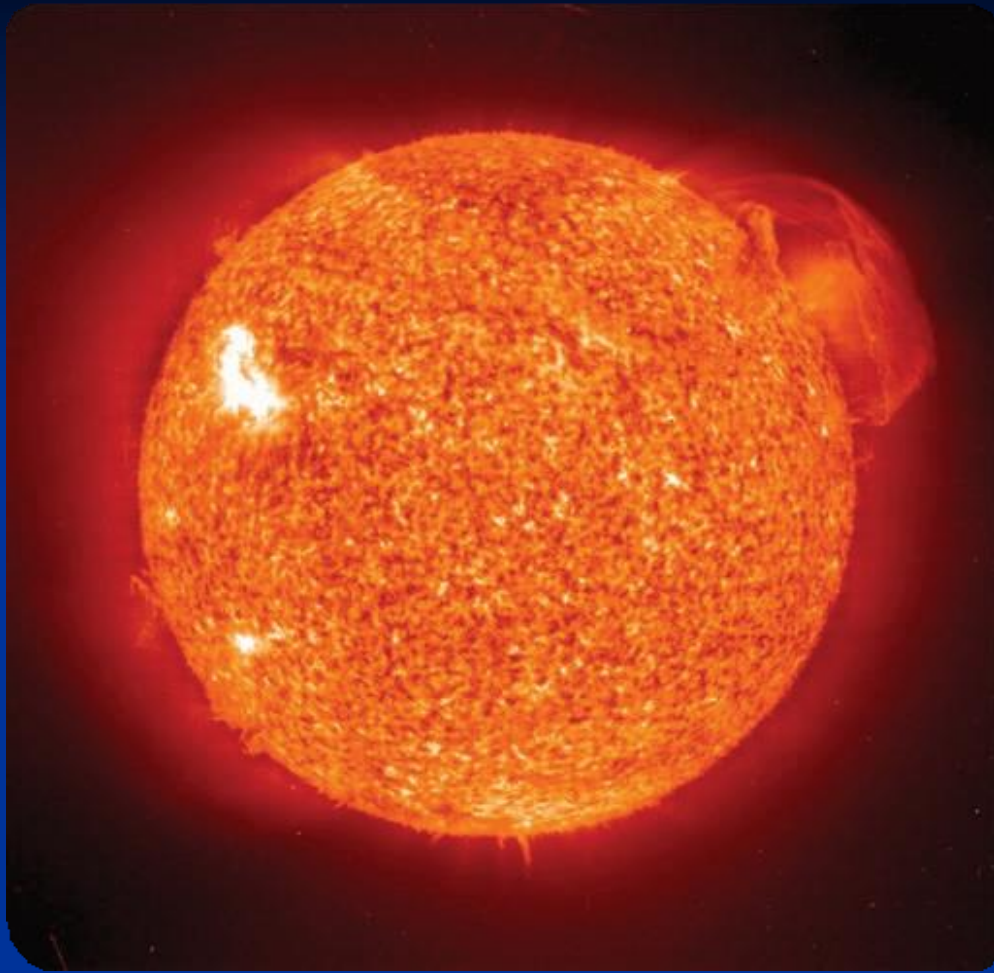
最小的恒星比最大的恒星寿命长得多，正如流言说的那样，“大的恒星老的快”。不过确实，当他们老了以后，他们会像红超巨星一样膨胀起来，并举办一场令人难以置信的超新星派对。



The little stars go more unnoticed... these stars are called black dwarfs because they are small and do not produce light. They gradually wither until they become cold and invisible in the universe....

小恒星不怎么引人注目...这些恒星由于很小且不发光而被称为黑矮星。它们逐渐衰弱，直到在宇宙中变得冰冷且不可见....





I, Matylda, am a medium star when I grow up I will also turn orange and I will be a giant, but not very big,....

我，马蒂尔达，长大后是一个中等大小的恒星。我也将会变成橙色，变成一个“巨人”，但也不是特别大，





....at this time I am still in the clinic's “nursery”. I am with all my sisters at my side and with remains of interstellar dust between us.

此时，我还在诊所的“育婴室”内。我和我所有的姐妹们在一起，在我们之间还有一些残余的星际尘埃。



...with the remains of material that I have so close and that when I spin around dancing around myself, it follows me like a ruffled skirt, I think I am going to form my planetary system.

当我绕着自己旋转跳舞时，我身边离我很近的残余物质就像一条褶边裙子一样随我一起转起来，我想我要形成我自己的行星系统了。



.... this takes tens of millions of years to make... so there is no rush!...

这需要花数千万年。所以不要着急！

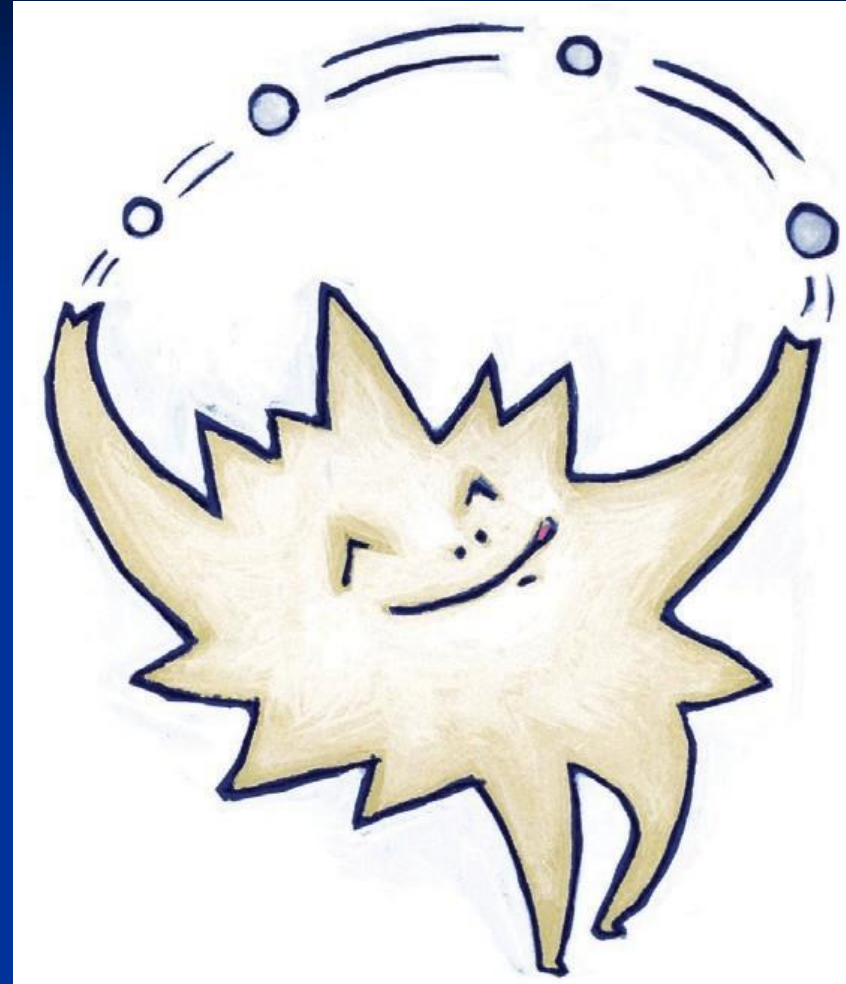


... quite a few million years have passed. Now I am a yellow star. I'm hotter than before. Yes, just like the Sun...

几百万年过去了，现在我变成了一颗黄色的恒星。我比之前温度更高了。对，正像太阳一样。

I already have my own planetary system...I love going with them everywhere, revolving around me. It's like juggling with friends.

我已经拥有我自己的行星系统。我喜欢带着他们四处游走。他们一直围着我旋转。这就像和朋友一起玩杂耍一样。



For now there are none of them that are inhabited, but **the appearance of life takes a long time to evolve**, so it may be that in a few years things will **change.**

目前还没有人居住在这些行星上。但是要知道生命的出现需要很长时间的进化，因此，也许在几年后事情会发生变化。...

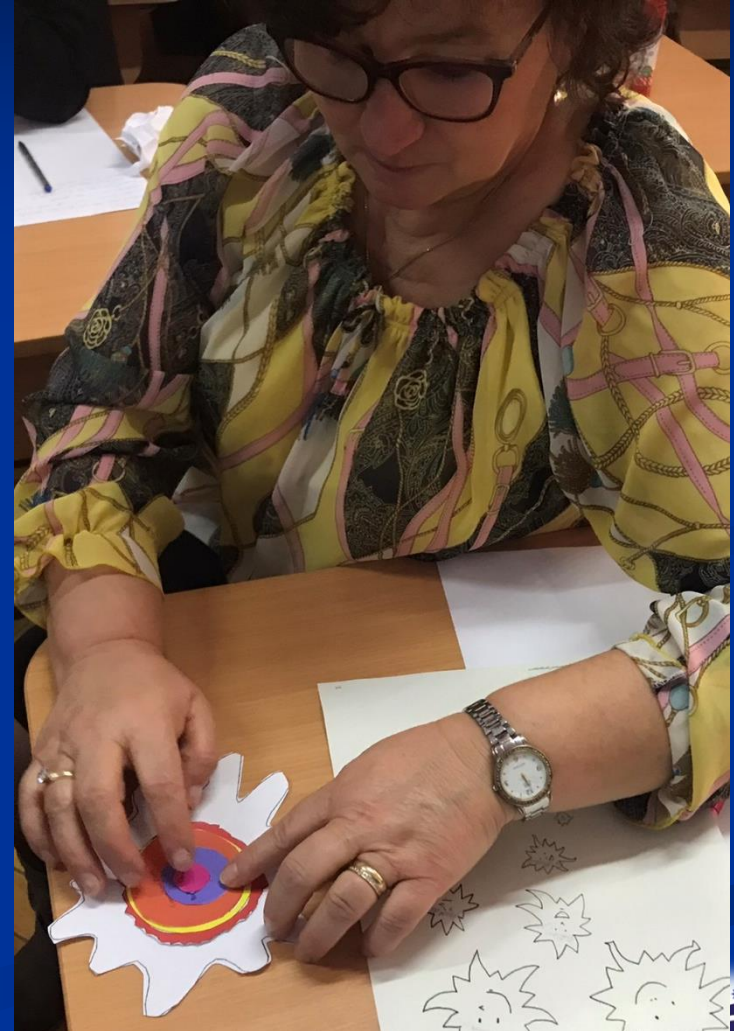


Activity 2: Model layers of the Sun

活动2：太阳分层模型

... the truth is that stars grow differently than children ... it is as if we grew from the inside. When I was born I was a ball of hydrogen and helium, ... in the universe almost everything is hydrogen, ...we form oxygen, carbon, nitrogen.....

事实上，恒星的成长和儿童是不一样的。比如说我们是从内部开始成长的。当我诞生的时候，我是一个由氢和氦组成的球。在宇宙中，几乎所有的物质都是氢。然后，我们形成了氧、碳、氮。

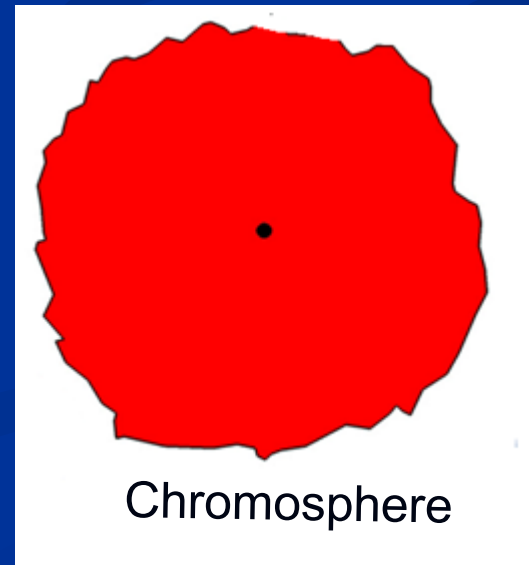
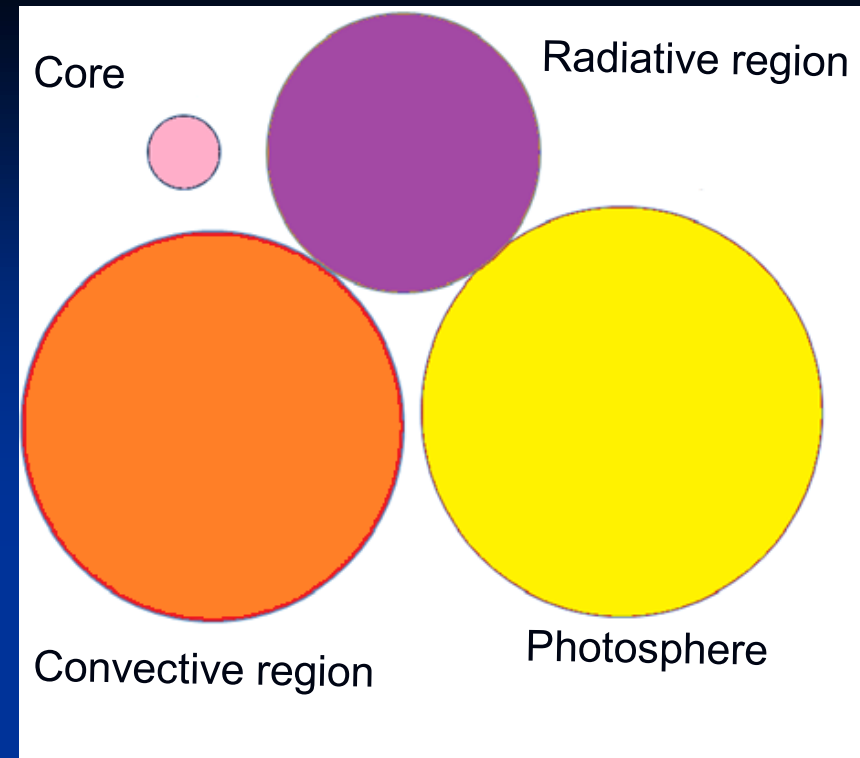


Activity 2: Model layers of the Sun

活动2：太阳分层模型

Simple layered model of the Sun. The objective is to cut out the different figures. They can be cut from different colored papers or painted.

太阳简单的分层模型。目的是剪出不同的图形。它们可以用不同颜色的纸剪成，或者直接把图形涂上不同颜色。

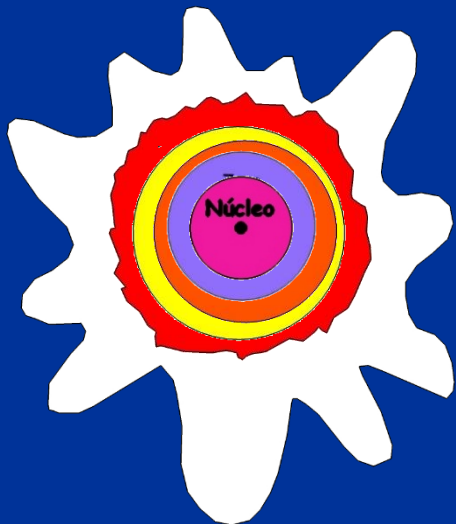
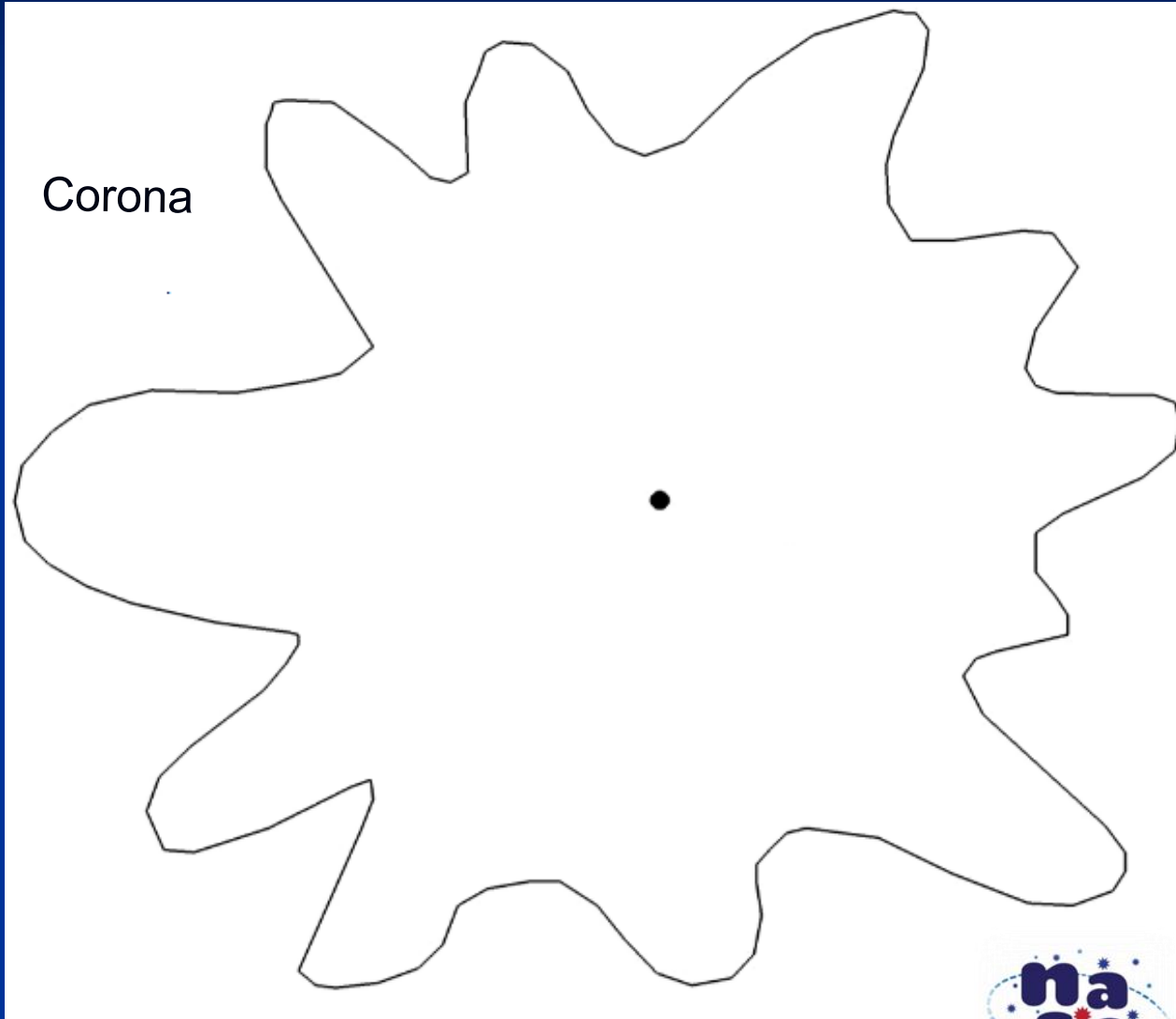


Activity 2: Model layers of the Sun

活动2：太阳分层模型

Finally, they are glued one on top of the other, in the correct order.

最后，可以按照正确的顺序，把它们一个挨一个的贴在一起。



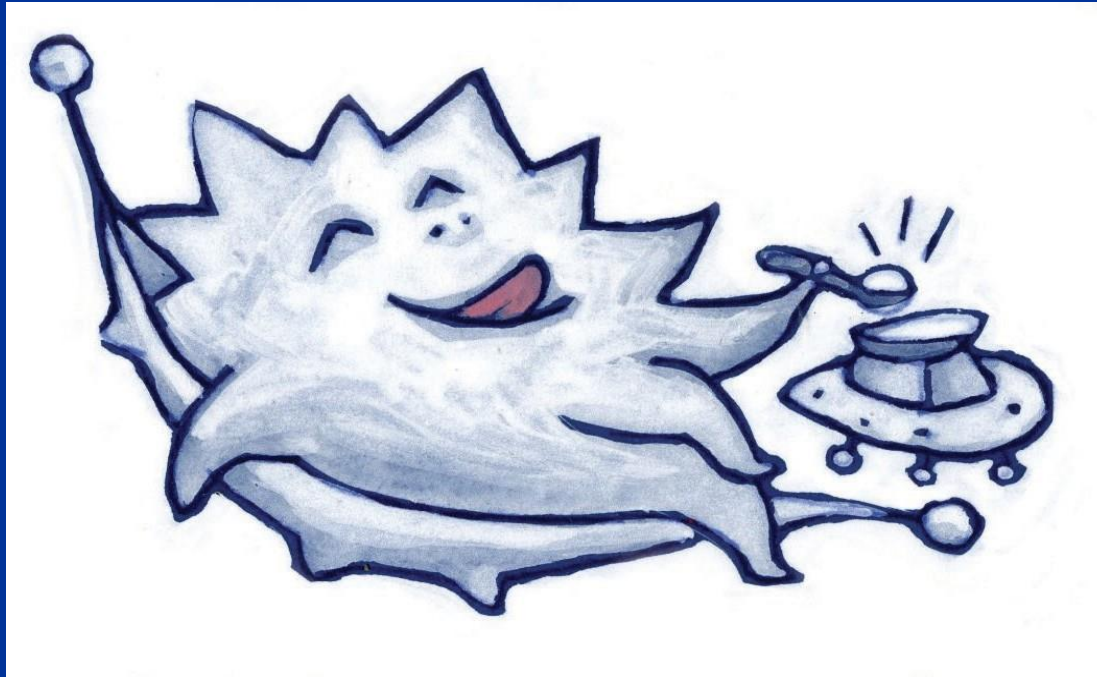
..... water is formed with hydrogen and oxygen... the molecules that give rise to life on Earth are basically made up of carbon. A carbon that was born in the belly of a star. So we are very important for life, we are fundamental.

水是由氢和氧元素组成的。在地球上产生了生命的分子基本上是由碳元素组成的。碳元素诞生于恒星的内部。所以我们（恒星）对于生命来说是非常重要的，我们就是生命的根本。



...my life is very relaxed, like that of the Sun, which is also a medium star. I hope to live about 10,000 million years eating hydrogen and manufacturing increasingly heavier elements in my belly and I will slowly cool down... very, very slowly...

我的生活是非常松弛的，就像同为中等大小的恒星——太阳一样。我希望能够通过吞噬氢来在体内不断产生重元素来活到100亿岁，并且我将会慢慢地变冷...非常非常慢...



Activity 3: Matchbox Model (spectroscope)

活动3：火柴盒模型（分光仪）

- To visualize the spectrum of sunlight and thus be able to know its composition
- 使太阳光谱可视化，得到其组成成分
- To find out what stars are made of
- 找出恒星是由什么元素构成的



Activity 3: Matchbox Model (spectroscope)

活动3：火柴盒模型（分光仪）

- Paint the inside of the box black.
- 将火柴盒内部涂成黑色
- Make a cross section to look at the spectrum inside the box.
- 做一个横切面来观察盒子内的光谱
- Glue a piece of CD to the bottom of the inside of the case (engraved area facing up).
- 在盒子内部底端黏贴上一张光盘（雕刻面朝上）。



Activity 3: Matchbox Model (spectroscope)

活动3：火柴盒模型（分光仪）

Close the box leaving only a slit open in the opposite area of the viewer.

关上盒子，只在观察者的对面留下一条狭缝。



- Use the spectroscope with sunlight to see the solar spectrum.
- 利用日光分光仪来观察太阳光谱
- Can also be used with classroom lights
- 也可以与教室灯光配合使用。

...as I generate so much energy inside I send bubbles of hot gas outwards, as they say, by convection...this means that, more or less, the heat comes out in the same way as it does when boiling a pot of milk. The particles at the bottom rise up through the center and then move a little towards the edge and down towards the bottom to rise again up through the center....



由于在我的内部产生了如此多的能量，我通过热气泡的形式将这些热量向外传输，这一能量传输过程也就是人们通常说的对流。也就意味着，或多或少，热量的释放方式与煮沸一锅牛奶的方式相同。底部的（较热的）粒子通过中心向上抬升，然后向外边缘移动一点，再然后向底部移动，之后再次通过中心上升。



Activity 4: Cake Model

活动4：蛋糕模型

To simulate the convection inside the Sun we can make a cake with chocolate so that we can visualize the movement of the chocolate inside the cake.

为了模拟太阳内部的对流，我们可以制作一个加有巧克力的蛋糕。这样就可以通过展示巧克力在蛋糕里的运动轨迹来展示对流运动。



Activity 4: Cake model

活动4：蛋糕模型

Ingredients:原料

3 eggs 3个鸡蛋

1 yogurt 1杯酸奶

1 glass of oil 1杯油

3 glasses of sugar 3杯糖

3 glasses of flour 4杯面粉

1 sachet of yeast 1袋酵母

1 glass of powdered chocolate

1杯巧克力粉

1 round mold 15-20 cm diameter

1个圆模具 直径15-20厘米

Procedure: 过程

Oven at 180° or 200°

烤箱设置180° 或200° 预热

Mix all the ingredients except the chocolate powder until you have a homogeneous dough.

将除巧克力粉以外的所有原料混合，直到面团均匀。

Pour half of the mixture into the mold, then add the cocoa powder and then carefully finish pouring the mixture

将一半的面团倒入模具中，加入巧克力粉，然后再小心地完成另一半面团的倒入。

Bake in the preheated oven 45 min

在预热好的烤箱里烤45分钟

Remove from the oven and let it cool

从烤箱中取出，冷却



Activity 4: Cake model

活动4：蛋糕模型

Procedure: 步骤

We can see the chocolate lines inside the cake that go from the center to the edges 我们可以看到蛋糕内部从中心到边缘的巧克力线

As the cake dough heats up, convection has begun and the dough has risen in the center and moved towards the edges in a circular movement that can be seen leaving the cocoa in the photo.

随着蛋糕面团的加热，对流开始了，面团从中心上升，并以圆圈运动的方式向边缘移动，这一过程可以通过照片中的巧克力看到。



...eventually, I will use up almost all of my hydrogen and then I will swell up and...be so big that everyone will call me a red giant. I will start burning my helium to convert it into carbon and oxygen... and prepare a big birthday party to celebrate having spent so many years forming new elements in my belly and “boiling the milk” on the surface. The 10 billion year birthday must be very special!!

最终，我几乎会耗尽我体内所有的氢，然后我就会膨胀起来，变得很大，（这个时候）每个人都会叫我红巨星。...我将开始燃烧我的氦，把它们转化为碳和氧。并且我准备举办一个盛大的生日派对，来庆祝我花费了这么多年在肚子里形成了新的元素以及在我的表面“煮沸了牛奶”。100亿岁生日一定很特别！！



...since I don't have enough matter, I won't be able to throw a supernova party with a big explosion.... throwing the outer layers outward in a cloud of gas and dust and leaving in the center a material so heavy that it does not let anything escape, not even light.a black hole....

由于我没有足够的物质，因此我没有办法举办一个伴随着大爆炸的超新星派对。举办超新星派对的时候，恒星们会将外层大气以气体和尘埃云的形式向外抛掷，在中心留下一团物质，这团物质非常的重，以至于它不会让任何东西（即使是光）逃出。这就是黑洞...



Crédito: cofeekai

... the dwarf stars that are withering and cooling until they are like a “withered fig” of red color, lost in the black sky...

...这些矮星会不断地凋零和冷却，直到它们看起来像一颗红色的“枯萎的无花果”，最终消失在黑色的天空中。



Activity 5: Ball model! 活动5：球模型

Simulation of a supernova explosion 超新星爆炸模拟

When a star explodes as a supernova, light atoms in the outer layers fall onto heavier atoms inside, and these bounce off the massive central core.

当一颗恒星以超新星的形式爆炸时，外层的轻原子会落到内部较重的原子上，随后这些原子会从巨大的核心反弹回来。



Activity 5: Balls model! 活动5：球模型

Simulation of a supernova explosion 超新星爆炸模拟

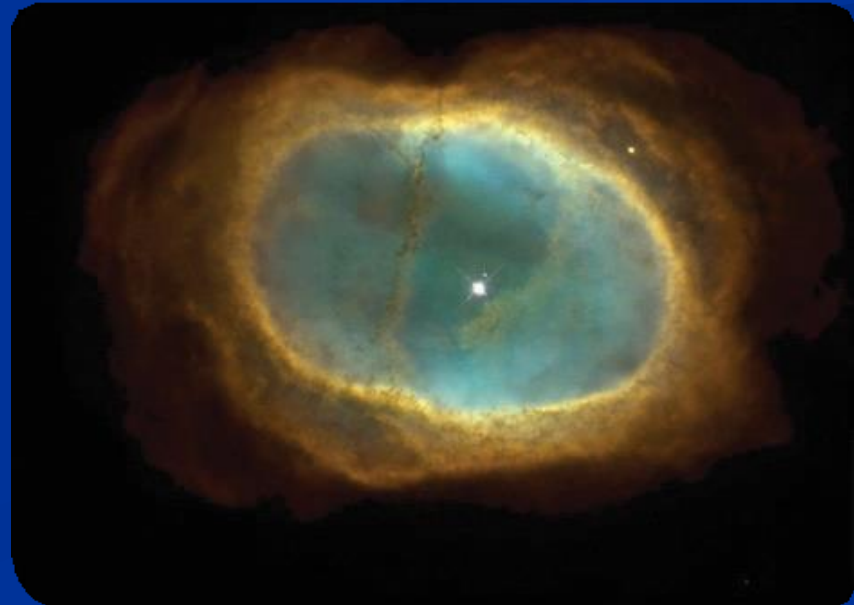
In this model, the ground represents the solid core of the neutron star, the basketball would be a heavy atom that bounces, and in turn pushes the light atom that comes after it, represented by the tennis ball.

在这个模型中，地面代表中子星的固体核心，篮球将是一个反弹的重原子，并反过来推动后面的用网球来表示的轻原子。



Since I am a medium star I have enough mass to throw a party.... It should be cool, without exaggerating, but not ridiculous either... my planetary system and I are going to end up as a beautiful nebula.

因为我是一个中等质量的恒星，我有足够的质量来举办一个派对....它应该很酷，不夸张，也不荒谬.....我和我的行星系统最终会变成一个美丽的星云。



... we are all going give rise to a beautiful nebula.... in the center there will be a small memory, a beautiful white dwarf... it will be a party with all my friends, all my planets and **we will launch into the universe a cloud of materials of which I have prepared throughout all these years.... Thus there will be other elements distributed in the sky in addition to hydrogen...** to help children be born.... All children are made up of the elements that my star friends and I have prepared inside ourselves throughout our lives.

我们都将会形成一个美丽的星云...在中心会有一个小小的记忆，即一个美丽的白矮星...这将是一个集合了我所有的朋友、所有的行星的派对，**我们将会发射一团我准备了这么多年的物质云到宇宙中（...因此，除了氢之外，天空中还会分布着其他元素...）**来帮助孩子们出生...所有的孩子都是由我和我的恒星朋友们通过一生在我们体内准备好的元素组成的。



...at your birthday parties you throw streamers and confetti, we **will throw stardust into space, which can be used in the creation of life...** to form children in their mothers' bellies.....

在你的生日派对上，你抛出彩带和五彩纸屑，而我们**将会向宇宙中抛出可用来创造生命的星尘.....**用于在母亲的肚子里孕育孩子.....



**Tonight, when you look at the sky, remember
that you are nothing but stardust.**
今晚，当你仰望星空的时候，请记住你不过是宇宙的星尘。



Conclusions

总结

- Show that stars evolve over time
- 展示恒星随时间的演化
- Give simple notions of the process of evolution
- 给出演化过程的简单概念



Thank you very much
for your attention!
感谢您的关注

