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Hidden Universe

By Russell Scott

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This is home.
Our very own
corner of the universe.
But stand here on the
surface of Earth and look up.
Hidden out here, in the
limitless reaches of space,
is the story of our past,
present, and future.
For centuries, astronomers
from every corner of the world
have striven to unlock
secrets of the universe.
This is Dr. Jonathan Whitmore,
and I suppose you could say
that he's always
had stars in his eyes.
I have
two great loves in life.
Music and astronomy.
As a kid I dreamt of playing
piano at Carnegie Hall one day,
then flying to some distant
mountaintop to stargaze the next.
But Carnegie Hall
will have to wait,
because I got hooked on
astronomy in a big way.
My very first
glimpse through a telescope
showed that even our closest
neighbors are stunning.
When I saw the moon,
I felt that I could almost
reach out and touch it.
Saturn has her amazing rings
that circle the planet.
The rings alone are
20 times wider than the Earth,
but in some places,
are only 10 meters thick.
And there's Jupiter.
The stormy gas giant.

We have one moon.
At last count,
she had more than 67.
But for me, the most
beautiful object in the sky
is the thing
we're all bound to.
The thing that gives us
warmth and life itself.
The sun.
Our sun is a star,
just like all the other stars
we see in the night sky.
When I found that out,
my mind was made up.
Jonathan's decision
to become an astronomer
led him halfway
around the world,
to one of the highest and
driest places on the planet.
Chile's Atacama
Desert is his launch pad
for a trip to
the edge of the universe.
When people find
out that I'm an astronomer,
they always ask me to point out
what I observe in the night sky.
And the truth is, I can't,
because the things I
study are so far away,
you can't see
them with human eyes.
That's what
I love about science.
It challenges our boundaries
and constantly pushes us forward.
Take Mars, for example.
Not long ago, we thought of it as
just a pale, red dot in the night sky.
Now we can see it in
extraordinary detail.
Starting in 1997,

the Mars Global
Surveyor mapped
the entire surface
of Mars so precisely,
that we could see detail
down to a mile in size.
It revealed huge canyons,
10 times longer
than the Grand Canyon,
and volcanoes three times
taller than Mount Everest.
More recently, NASA sent
the Mars rover, Curiosity.
It's a mobile lab that is
scouring the landscape
for water and
interesting samples.
And from orbit, we are mapping
Mars with incredible precision.
We can now see rocks on the Martian
surface that are barely a foot wide.
These images
of the surface of Mars
aren't some special effect
created for the next
Hollywood sci-fi epic.
This is the real thing.
These images were
taken using HiRISE,
the largest telescope ever
carried on a deep-space mission,
aboard the Mars
Reconnaissance Orbiter.
If you've ever
dreamt of living on Mars,
just come to
the Atacama Desert,
and you'll be amazed by how similar
it is to the Martian landscape.
In the middle of one of
the world's most arid deserts,
the team at ESO have constructed
a place that's full of life.
This is where we live.

In fact, if we ever
colonize another planet,
this might be the kind of
biosphere that we build there.
Sheltered from the
extreme conditions outside,
you'll find an oasis,
with all the comforts of home.
A swimming pool,
a library, a restaurant,
and even a music room
where I can practice piano.
Astronomers from all over the
world are drawn to this place
by their passion
for the stars.
And up the mountain is the
telescope we have all come to use.
It's called the "VLT".
The Very Large Telescope.
So we're not exactly that
great at coming up with names,
but that's exactly what it is.
A very large telescope.
Make that four
very large telescopes.
VLT operator
and mountaineer, Lisa Tura,
is here to prepare
the telescope.
On her days off,
you'll find Lisa scaling the
highest peaks of the Andes.
So she is unfazed by the task
of calibrating these gigantic,
and sometimes
temperamental, machines.
When you
operate the VLT,
you have to treat it
with the utmost care.
One miscalculation
can throw out
an entire night's

observations.
Its instruments
are so sensitive
that even your body's temperature
can affect the readings.
So we need to be
extremely thorough
every time we start it up.
The VLT is one of the biggest
optical telescopes in the world.
It has a 27-foot mirror that
acts like a giant light bucket,
capturing as much
light as possible.
This main mirror
reflects and focuses the
light up to a second mirror,
then down to a third mirror
in the middle of a telescope.
And finally,
into instruments on
the side of the VLT.
Once Lisa
has finished her calibrations,
the VLT can see objects
four billion times fainter
than those detectable
by the human eye.
For me, music will always
play a big part in my life.
But when I'm about to look up
and see distant objects that
no one else has ever seen,
I know I've made
the right choice.
Before
the night's viewing begins,
everyone must
leave the building.
The VLT demands
total darkness.
As I said, temperamental.
Every speck of man-made light
has to be shut out.

Even the tiniest bit could ruin
the observation for that night.
As the Earth spins,
the Milky Way
appears to pass over us,
while the telescopes
twist and turn,
tracking distant
objects in the sky.
Nowhere else in the world can you
see the stars shine as brightly.
On the clearest of nights,
you can see your own shadow,
cast from the light of
millions of distant stars.
And as we explore the heavens,
we have found
the birthplace of stars.
This monstrous cloud of gas
and dust is the Carina Nebula.
It's a star factory,
churning out
thousands of stars,
some of which are the
brightest in our Milky Way.
You could
call it a stellar nursery.
Because in
a nebula like this one,
stars are being formed.
And even though these stars
are relatively young,
they're not exactly small.
And there are a huge
range of star types.
In fact, our own sun would have been formed
in a cloud of gas and dust just like this.
Sometimes, these nebula are named
by the shapes that they seem to make.
Here's one with
a great nickname.
The Snow Angel Nebula.
The blue wings of the snow
angel are actually hot gas,

being illuminated by a huge star
forming in the middle of this hourglass.
The astronomers who named
the War and Peace Nebula
could see a dove
dancing in the gas.
I don't see it myself,
and I'm more interested
in the gigantic stars here.
They're shining hundreds
of thousands of times
brighter than our sun.
But not every
nebula is a stellar nursery.
A thousand years ago,
Arabian, Japanese
and Chinese astronomers
all recorded a strange,
lingering light in the sky,
as bright as the full moon.
They were witnesses
to the death of a star.
A supernova explosion that
scattered gas and dust particles
60 billion miles
into the cosmos,
forming this.
The Crab Nebula.
Sometimes, astronomers
look deep into the sky
and see the cosmos
looking right back at them.
This magnificent
eye in the sky
is just the remnants
of a burned-out star
that has shed its outer layers
back into the universe.
By studying
formations like this,
we now know that stars
come and go from the universe.
Just like life begins
and ends here on Earth.

Beyond our Milky Way,
you'll find stars,
gas and dust
clumped together in huge
structures called galaxies.
Galaxies come in
all shapes and sizes,
but what I love
most about them
is that the light that I'm seeing
was created way back in time.
Light from even
the closest large galaxy
takes two and a half million
years to reach us.
And the deeper I
look into space,
the older the light I see.
This means that galaxies
are like fossil records
of how the universe
used to look and act.
So in a way,
my work is a little bit
time travel
and a little bit
cosmic archeology.
I'm trying to help decipher
these distant records
so that we may one day
better understand
the story of our universe.
Since these
objects are so far away,
a new challenge faces
optical astronomers.
Like the heat distortion
you see on a road,
the atmosphere distorts and blurs
light coming in from the universe.
It's what makes the stars
appear to twinkle at night.
To counter this problem,
the VLT has a trick

up its sleeve.
It fires a laser beam 60 miles
up in to the night sky
to create a fixed point.
Almost like a fake star
for the telescope to focus on.
On the ground,
the VLT compensates
by warping the telescope's mirror
hundreds of times per second,
allowing us to capture
the sharpest of images.
If you want
to see what I'm looking for,
don't look at the main
part of these pictures.
Look further, deeper,
into the details of the image.
My work takes me beyond all
these close celestial objects
and out into the vast
universe that lies beyond.
Highlighted here
are distant galaxies.
They're similar in size and
structure to the closer ones,
but they are so far away
that even with the VLT,
you can barely make them out.
These are the galaxies
that I study.
Out here are the frontiers
of our knowledge.
This image is as far back
in time as we can see
with an optical telescope.
It is the edge of
the visible universe.
I chose
to become an astronomer
when I learned that
our sun is a star.
You know, we have looked over
13 billion years into the cosmos,

and everywhere we look,
we find stars like our sun
and galaxies
like our Milky Way.
When you see all
of these galaxies,
you can't help but feel a profound
connection to the universe.
Here in our cities,
the digital world is producing
a new breed of astronomer,
using telescopes and supercomputers
to create detailed simulations.
They see the world
differently.
Dr. Greg Poole is one
of those astronomers.
He is a universe-builder.
But the glow of bright
city lights of technology
drowns out our universe.
When we look for the heavens,
we can't see them anymore.
That's why when Greg gathers his
data for his cosmic simulations,
he too has had
to pack his bags
and head for the
Atacama Desert.
Greg has come to use the most
powerful telescope ever built,
but his passion
for photography
won't let him pass
up an opportunity
to capture the
Atacama's night sky.
I love this place.
It has a peacefulness
that clears your mind.
The ancient
Incas who lived here
organized their lives
by the night sky.

The movement and position of
the stars told them when to
plant and harvest their crops.
They must have felt a kind
of kinship with the stars.
And when you see the night sky
as they would have,
it's not hard to see why.
Greg isn't the only one that
sees the world differently.
This mosquito is on the prowl
for its next meal.
As it hunts,
it sees the world in a very
different way than we do.
It doesn't just
see visible light.
It also has
an array of sensors
that detect infrared
heat signatures.
That's how it can
find you in the dark.
And it will.
Like the mosquito,
a new telescope called "ALMA"
is being built to detect
signals outside of visible light.
ALMA is an extraordinary
collaboration
between the European
Southern Observatory,
North America and East Asia.
A decade of work
is almost complete.
If you're thinking this looks
more like a construction site
than a telescope,
you'd be right.
This is base camp.
ALMA has a completely different
design from optical telescopes,
because it's looking
for microwave signals.

And the best place for
a microwave telescope
is high and dry
at over 16,000 feet
on the top of a mountain.
But 16,000 feet is not a place
you can work for very long.
The thin air and dryness
make it hard to breathe
and altitude sickness
can lead to unconsciousness
or even death.
So engineers here have come up
with a creative solution.
They're building
each individual antenna
at a low-altitude base camp.
And then each hundred-ton dish
is driven up the mountain,
one giant piece at a time.
Normal vehicles
aren't up to the task,
so engineers have built
the world's biggest
remote-control truck.
An operator can guide each
antenna into its place in the array
by using laser-guided steering
and collision detectors.
These safely guide the dish
onto a concrete pad,
where it will be ready to
power up and get to work.
Every time
I see ALMA,
I think of how far we've come.
This isn't just
a big telescope.
It's an array of 66 dishes
that are connected by
a giant supercomputer
to make these separate dishes
act as one huge "eye in the sky".
It makes ALMA the most

powerful telescope ever built.
Bathed in its eerie,
green light,
ALMA lets us peer into the
farthest corners of the universe.
These are the Antennae galaxies
when viewed by normal, optical light.
But ALMA sees so much more.
One of her first images
was a revelation.
A huge, dense cloud
of hydrogen gas
hidden within the galaxies.
Enough gas to form
more than a billion stars.
Centaurus A was the first
galaxy I ever studied.
Using telescopes like ALMA,
we can see a massive black hole
at the center of this galaxy.
It's spewing out plasma at
almost half the speed of light.
Every galaxy, nebula
and star in the sky
has secrets hidden from us.
Take the Crab Nebula.
We know that it was once a star that
blew up in a supernova explosion.
We know this because when
we look with X-ray vision,
we can see the compact remains
of that exploded star.
A pulsar.
But there is still
more to the story.
Because infrared observations
penetrate deep
into the dusty
clouds of this nebula,
revealing elements like hydrogen,
carbon, silicon and iron.
All of these observations
reveal an incredible truth.
That stars are the factories

of the universe,
continually creating
the basic elements
necessary for
everything to exist.
And as stars die,
they disperse these elements
back into the universe.
We are made from the stars.
The collective knowledge
of years of observations
has revealed our true
connection to this cosmos
and has allowed me to create
one of the most detailed simulations
of the universe ever constructed.
Each one of these points
of light is a galaxy,
just like our own Milky Way.
Our universe contains billions
and billions of galaxies,
and each galaxy has
billions of stars.
The universe is
unbelievably vast.
And even though we may be
small in comparison,
we are not insignificant.
Everything we are,
every single piece of us,
everything that we see,
feel, or taste,
was made possible
by the stars.
It's no wonder we constantly
set our sights higher
and aspire to know ever more
about the universe.
NASA is building
the successor to Hubble,
the James Webb
Space Telescope.
It will help us see from our
small perch in the Milky Way

to the very edges
of the universe
and the beginning
of time itself.
We live in the universe,
and the universe lives in us.
So when we look up
into the night sky,
the story we see
is our own.