Supernovae are the most powerful explosions in the universe, unleashing enough energy to outshine

galaxies. We have no real metaphor for their power – if the sun were to magically go supernova it

would feel like you were being hit by the energy of a nuclear explosion, every second. For weeks.

While supernovae are the engines of creation, forging the elements that enable life, they also

burn sterile whole regions of galaxies.
So what would happen if one hit earth?

There are roughly speaking two ways to make a supernova. Either the core of a

massive star implodes, or, less common, a white dwarf gains mass to the point where

it ignites explosive nuclear fusion. The outcome is the same: a supernova explosion.

If we think of an explosion on earth, we think of something that happens fast and ends.

But a supernova is more like a volcanic eruption followed by a tsunami. At first

there is a colorful ball of hot, expanding gas, creating a spectacular cloud that will shine for

about a month – but then it doesn't stop. Hot and dangerous gas rushes outward at speeds of

10,000 km/s through the near vacuum of space, sweeping up the sparse gas of the galaxy.

This wall of gas expands for tens of thousands of years and will eventually span up to dozens

of light-years until it finally cools off, and disperses its substance back into the galaxy.

So what if this star tsunami hits us? Well, the damage depends on how far away it is.

Stage 1: Thousands of Light Years away

Humans have witnessed dozens of supernovae but all of them were thousands of lightyears away.

They appeared as new stars, some outshining the moon, twinkling for a few weeks and

disappearing. Aside from looking very pretty at this distance they don't do much to us.

Stage 2: 300 Light Years away

Things begin to get a tiny bit

icky once a supernova occurs around 300
lightyears away. We can expect one this

close to us every few million years:
a single star giving the night sky

an eerie glow like twilight. And while this
is far and dim enough not to do harm to us,

they can affect the earth. At these distances
it is like being hit by the last weak waves

of the star tsunami. Not strong enough
to do real damage but still noticeable.

In fact, we know that over the past 10 million
years multiple supernovae have struck Earth from

these distances because we can find radioactive
isotopes of iron deep in the rocks and sediments

at the bottom of the ocean. Amazingly, these
supernovae around the solar system have cleared a

1000 light-year wide pocket of space that is
called the 'Local Bubble'. They blew away the

interstellar gas and dust, creating a lumpy wall
of gas that is now a cradle for star formation.

Stage 3: 150 Light Years Away
Once a supernova happens much closer

than 300 light-years, we're approaching
the zone where it does real damage.

Stars have extremely powerful magnetic fields.
When they die, the tsunami of dead star actually

retains a lot of this magnetic energy, woven
through the shockwave that expands outwards.

In this highly magnetized cloud,
we get conditions like in a huge

particle accelerator that is accelerating
charged particles like protons, nuclei,

and electrons to immense speeds. Which means we
have an expanding cloud that is shooting deadly

radiation in all directions, long after the bright
light from the initial explosion has faded away.

If a supernova happens too close by, waves
of these 'cosmic rays' will wash over the

solar system for thousands of years. While
we're mostly protected on earth's surface

by the atmosphere and ozone layer, the influx
of extra radiation will still increase cancer

and mutation rates. Not enough to cause a
mass extinction but it will be noticeable.

Spaceflight would become
impossible in the solar system,

as astronauts would not survive
the waves of radiation for long.

We don’t know exactly how bad this would
be, but a supernova that is close enough may

trap our species on earth for generations, maybe
thousands of years. It only gets worse from here.

Stage 4: Closer than 100 light years
Within 100 light years, things get bad,

as a supernova disrupts our climate in
ways that we don't fully understand yet.

There are a few unpleasant things
happening all one after another:

First, the high energy photons arrive from the
explosion, followed by many decades of radiation

from the radioactive tsunami, both of which
seriously damage the ozone layer, earth’s shield

against harmful radiation. The ozone layer absorbs
ultraviolet radiation by breaking apart ozone, O3,

into O2 and a free oxygen atom, which later
reforms back into another ozone molecule.

But the supernova radiation breaks up Nitrogen
molecules that gobble up the free oxygen,

breaking the cycle and depleting the ozone
layer quickly: Without a radiation shield

everybody living on the surface is exposed
to very high levels of UV radiation from our

sun – cancer rates would skyrocket and just going
outside during the day could be life threatening.

The extra radiation would also kill a lot, if not
most of the plankton in the oceans that live near

the surface and are the basis for the marine
food chains – leading to a mass extinction.

Worse still supernova radiation would ionize gas
in the atmosphere, which means that it would punch

through molecules and knock electrons off nuclei, leaving them charged. These charged nuclei then

act as seeds for water vapor to gather and form massive global clouds. In the worst case they

would reflect enough sunlight to trigger an ice age. In fact, it's thought that the ice age 2.5

million years ago was caused by a supernova. Some scientists even think that a supernova about 60

light years away might have been the cause for the Devonian mass extinction 350 million years ago.

But wait, there is more. The electrons punched free by the radiation, form enormous electric

avalanches – or in other words: lightning. Earth is hit by some of the worst thunderstorms in

millions of years. The intense lightning causes global wildfires that consume forests and crops,

devastate cities, disrupt our electrical grids and global supply chain. All while

a decimated ozone layer leaks deadly radiation. While in the past, the ecosystem may have bounced

back from a nearby supernova after a few thousand or million years, there’s no guarantee modern

civilization can take a hit of this magnitude. Food shortages, skyrocketing prices, and wars,

as nations struggle to not be consumed by chaos. So a supernova this close would at the very least

do significant damage for hundreds or thousands of years, if not end our modern civilization, and

with it millions or even billions of lives. Still, humanity would likely survive and could recover.

Stage 5: Closer than 25 light years
A supernova closer than 25 light years

means that we’re in its ‘kill radius’ where a mass extinction is all but guaranteed.

Probably about half of the ozone layer would be destroyed, and massive climatic disruption

on a scale we have never witnessed would ravage earth. Entire ecosystems would swiftly be wiped

out by radiation, as global wildfires envelop the planet. All the things described before happen,

but way more intensely and much faster. A few

people might survive for years in bunkers,

if they have food supplies, but the world
they return to will be devastated and

hostile to life for hundreds of thousands of
years. Human extinction is extremely likely.

Final stage: 4 light years
Being any closer to a supernova is very

unlikely because space is big. But the effects
would be extreme. Even from 4 light years away,

the distance to Alpha Centauri, a supernova would
be almost as bright as the sun in the sky. While

casting two shadows could be fun for a few hours,
within days the earth's surface gets as hot as a

sauna, baking the surface for weeks until the
explosion fades. The surface of earth burns,

scoured of life. Even the oceans aren't
safe: the massive amount of radiation

that follows burns away the ozone layer,
killing everything that sees sunlight.

It would be the largest extinction event in
history, reducing life to a few survivors

in the deep sea and critters in the deep
soil. Life basically has to start over.

Conclusion: How worried do you need to be?
So should you worry? No! Fortunately,

there are only a handful of stars that may explode
within 1000 lightyears of earth and none are close

enough to be a serious threat. Even better, these
stars will probably not go supernova for many

millions of years. So you are safe. But there's
no guarantee for the far future. As stars orbit

the galaxy, our descendants may find themselves
dangerously close to a supernova – but by then

a far more advanced and wiser humanity will
hopefully be able to just move out of the way.

In any case, you can sleep well
tonight under the beautiful night sky.

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