# THE LIVES OF STARS

## and the search for habitable worlds

National Aeronautics and Space Administration

Like ancient explorers who looked to the stars to guide them to new worlds, astronomers today use stars to discover worlds many light years beyond our solar system. By studying stars and their unique influence, we can learn a great deal about their worlds – even their potential to sustain life as we know it.

## BIRTH

Stars are born in clouds of dust and gases that clump together in the extreme cold of space. The clouds get so dense that they eventually collapse and produce a reaction called nuclear fusion, which fuels the star. The material that surrounds a star during birth determines its mass, its future and the future of its planets. (Planets form from less than 2% of the stellar material surrounding the star.)

15 AU
*SCALE ADJUSTED FOR VISIBILITY
450 AU
42 BILLION MILES

OPHIUCHUS CONSTELLATION (366 LIGHT-YEARS)

### ZETA OPHIUCHI

While they're easy to spot in the night sky, O-type stars like Zeta Ophiuchi are the most rare. We haven't yet found any planets orbiting one. Planets that do exist likely have been stripped of their atmospheres by these stars' strong ultraviolet light. These stars are so massive that they go through their entire lifecycle and explode in a supernova while most stars are still forming.

10 MILLION YEARS | 0 | WEAK | .00003%

15 AU
1.4 BILLION MILES

ANDROMEDA CONSTELLATION (168 LIGHT-YEARS)

### KAPPA ANDROMEDAE

This B-type star's only known planet may not be a planet at all, but a failed star called a brown dwarf. In either case, habitable worlds around Kappa Andromedae are unlikely given the star's temperature, brightness and short lifespan.

600 MILLION YEARS | 1? | WEAK | .03%

## ADULTHOOD

Once the star stabilizes, it enters adulthood (known as "the main sequence") where the Sun now resides. The relative calm is an ideal time for planets to evolve – and for life to form. But not all stars will be hospitable to life.

15 AU
1.4 BILLION MILES

PISCIS AUSTRINUS CONSTELLATION (25 LIGHT-YEARS)

### FOMALHAUT

A bright, hot and short-lived A-type star, Fomalhaut will quickly push its habitable zone outward as the star ages and expands. This may be good news for its only known planet, which is far beyond the current habitable zone. But will it be enough time for life to evolve? It's unclear.

1.7 BILLION YEARS | 1 | UNCERTAIN | .4%

15 AU
1.4 BILLION MILES

ANDROMEDA CONSTELLATION (44 LIGHT-YEARS)

### TITAWIN

Close in age to our Sun, this F-type star has one known planet in its habitable zone. The gas giant planet is unlikely to support life except on any large, rocky moons. But with just one billion years left to live, Titawin's habitability will soon fade away with the star itself.

5.3 BILLION YEARS | 4 | GOOD | 2%

15 AU
1.4 BILLION MILES
EARTH

93 MILLION MILES

### THE SUN

With its ideal lifespan, brightness and temperature, the sun is our point of reference in the search for habitable worlds. Yellow (G-type) stars make up 8% of the estimated one billion trillion stars in the universe, so finding an Earth-like planet around such a star may just be a matter of time.

11 BILLION YEARS | 8 | GOOD | 3%

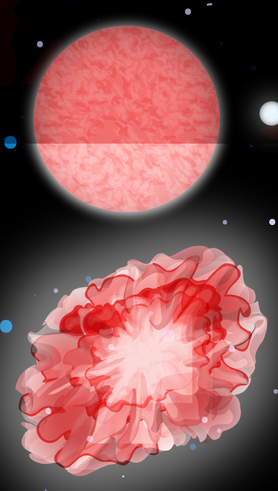
## THE SEARCH FOR HABITABLE WORLDS

Stars influence the habitability of their planets in two key ways. Their brightness and temperature create an area known as a habitable zone, where conditions are just right for liquid water to pool (a key ingredient for life on Earth). And the star's lifespan tells us how long life has to form and evolve before the star makes the planet uninhabitable. Explore the real stars plotted here (sized to scale) with their habitable zones to discover how each star influences its planets and their habitability.

HABITABLE ZONE (ASTRONOMICAL UNITS, AU)
LIFESPAN (YEARS)
KNOWN PLANETS
HABITABILITY FACTOR (GOOD, UNCERTAIN, WEAK)
LIKE-STARS IN THE UNIVERSE (PERCENTAGE)

## DEATH

All stars, even the Sun, will eventually age and die. Most kinds of stars grow into red giants then collapse into cool, dense stars called white dwarfs. The highest mass stars explode violently as supernovas or even form black holes. The current age of the universe is 13.8 billion years, far shorter than the expected lifetime of the smallest stars, so their fate is still a mystery.



*ILLUSTRATIONS NOT TO SCALE

15 AU
1.4 BILLION MILES

LYRA CONSTELLATION (1,120 LIGHT-YEARS)

### KEPLER-442

This orange (K-type) star is only about half as old as our Sun, but it will live much longer, giving its planets more time to evolve. Scientists have discovered a planet slightly larger than Earth, Kepler-442b, orbiting the star at a distance hospitable to life.

40 BILLION YEARS | 1 | GOOD | 12%

15 AU ← 5 AU
465 MILLION MILES
*SCALE ADJUSTED FOR VISIBILITY

AQUARIUS CONSTELLATION (40 LIGHT YEARS)

### TRAPPIST-1

Red dwarfs (M-type stars) like our nearest neighbor, Proxima Centauri, are much cooler and dimmer than our Sun with relatively tiny habitable zones. A tightly packed system of seven Earth-size planets with orbits ranging from 1.5 to 20 days surrounds Trappist-1 – three in the habitable zone.

4,000 BILLION YEARS | 7 | UNCERTAIN | 78%