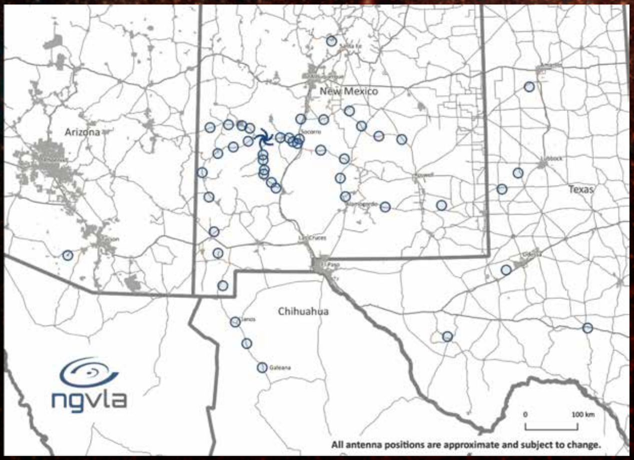
MASSIVE STAR FORMATION

STAR FORMATION

AND THE NEXT GENERATION VLA

The youngest star forming regions are by their nature “hidden”, buried deep in the centers of molecular clouds. Because of their location, many young star forming regions are invisible at optical wavelengths. In optical images of the Milky Way Galaxy (like the background of this poster), molecular clouds appear to be dark bands and smudges. If we are to understand star formation better, we need telescopes that can see into these hidden regions: radio telescopes.

The Karl G. Jansky Very Large Array (VLA), dedicated in 1980, is a radio telescope that consists of 27 82-foot (25-meter) dishes arranged in a “Y” shape in the high plains of New Mexico. The individual telescopes are movable, and in its largest configuration, the VLA covers over 35 km (22 miles). It received a major update in the first decade of the 21st century, and now plans are being made to build the next generation Very Large Array (ngVLA). The ngVLA will contain almost 10 times as many telescopes (244 to be exact) and be spread out over 200 times the distance (5505 miles, or 8860 km). The ngVLA will be able to detect fainter objects (be more sensitive), and make sharper images (have better resolution) than the current VLA. These capabilities will make the ngVLA the world’s premier radio telescope well into the 21st Century.



Left: The Very Large Array (VLA) in New Mexico; Right: a map of the planned dish layout for the main array of the ngVLA, showing how the >200 new telescopes will span several states and even have locations in northern Mexico. (Credit: NRAO/AUI)

Background: The plane of the Milky Way is filled with stars, and also dark areas that indicate the presence of gas and dust. These dark regions are the ones that radio telescopes can explore. (Credit: NASA, ESA, and Hubble Heritage Team)

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MASSIVE STAR FORMATION

HOT GAS

AND “FLICKERING” REGIONS IN W49A

Deep within molecular cloud cores, invisible to the world’s best optical telescopes, clouds of gas collapse via gravity to form thousands of young stars. Most of the stars that form are relatively small, the size of the Sun or smaller. But a few of the stars formed are enormous (10-50 times the mass of the Sun), and live short lives, burning through their nuclear fuel in only a few million years. The most massive of these young stars are hot enough to ionize the hydrogen around them (that is, tear apart the protons from the electrons), and create regions of high temperature gas called HII regions. The smallest of these regions are called ultra compact HII regions. As these hot stars move through the cloud of material that they formed from, they flicker between being able to ionize larger and smaller regions. If they travel into a very dense region, they cannot ionize as much of it, and will appear small. These "flickers" can happen quickly, detectable to astronomers making observations over only a few decades.

W49A is one of the most massive star forming regions in the Milky Way, located on the far side of the Galactic Center, a whopping 11,100 kiloparsecs (36,000 light years) away. The photons just now reaching the Earth from these regions left them before recorded human history. Despite being so far away, some of the HII regions detected in W49A are very small, only a few hundredths of a light year across. One of the sources in this region (circled) has been “flickering” recently.

Background Image: The central portion of the massive star forming region W49A as imaged with the Very Large Array at 3.6 cm. The colors in this image indicate the brightness of the sources. The source W49A/G2 (circled) has been observed to change dramatically in brightness over the past 20 years. (Credit: C. De Pree/NRAO/AUI)

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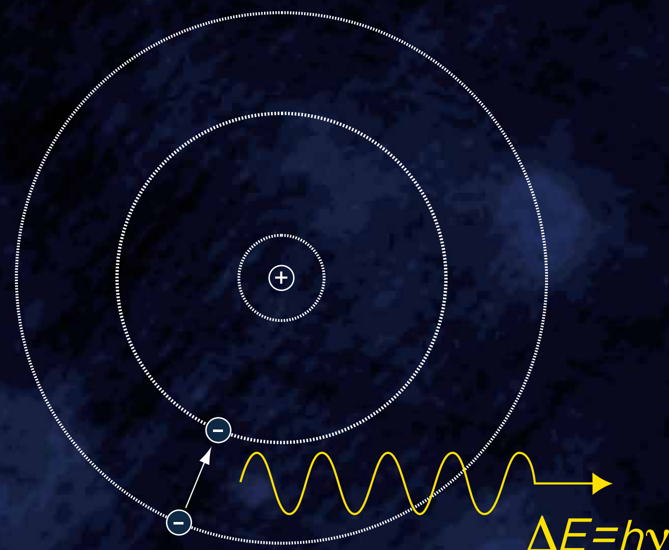
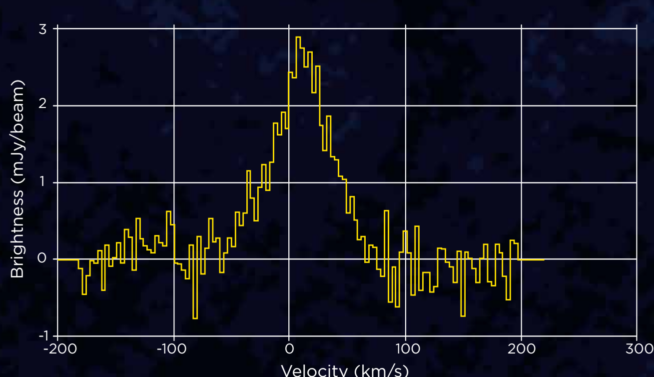
SPECTRAL LINES

AND WHAT THEY CAN TELL US

Matter is composed of protons and electrons, and the simplest and most abundant atom (Hydrogen) consists of just one proton and one electron. The proton is positively charged and the electron is negatively charged, and they tend to want to hold on to one another. When you put a hydrogen atom (in one of those dark molecular clouds) near a high mass star, the energy streaming from the star in the form of photons tears the protons and electrons apart. This tearing apart is called *ionization*. When an electron and a proton come back together, it is called *recombination*.



Negative electrons that have *recombined* then try to get closer and closer to the positive proton, moving through specific energy levels, like the rungs on a ladder. Each time an electron moves down a ladder rung, it gives off a photon with a specific wavelength, creating a spectral line (seen below). Some of the photons that come streaming out of the hot gas around these stars (called HII regions) are in the radio part of the spectrum. These *spectral line photons* can tell us about the ionized gas around a high mass star: how hot the gas is, and how fast it is moving. It seems that "flickering" regions are often associated with gas that is moving very fast, streaming away from the star at high velocity.



Background: A wide view of the W49A star forming region as observed with the VLA at 3.6 cm. The tight, bright grouping of HII regions in the center of the image are the same ones seen in more detail in the "Hot Gas" poster (Credit: C. De Pree/NRAO/AUI)

Diagrams: Top Right – The Bohr model of the atom, showing that as electrons move down in energy levels, they give off photons. Bottom Left – This spectral line was detected with the Very Large Array from the source W49A/G2 (circled in the "Hot Gas" poster). The fact that the spectral line covers a wide range of velocities tells us that there are very fast moving clouds of gas in this distant star forming region.

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