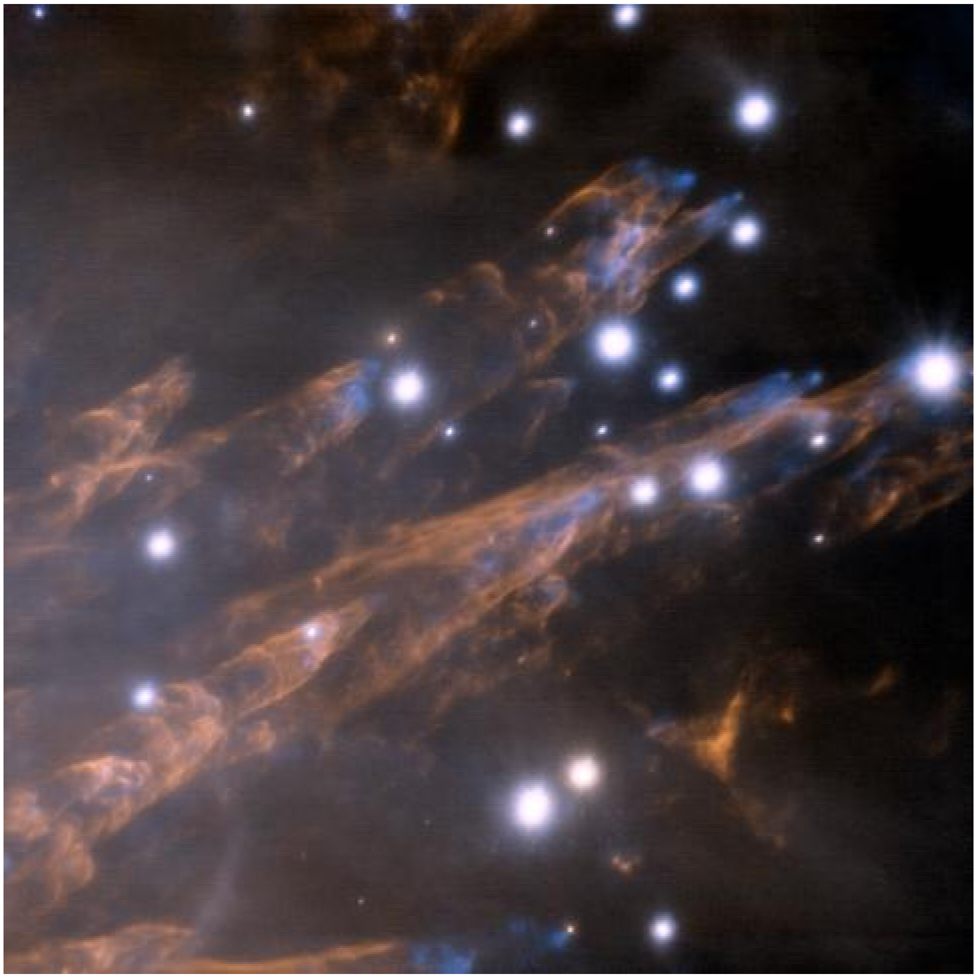
Supersonic "bullets" in Orion

A new Gemini image shows massive gas bullets speeding away from the Orion Nebula.

Provided by the Gemini Observatory



This composite image at infrared wavelengths was obtained using the Gemini North laser guide star system in conjunction with the ALTAIR adaptive optics system and the NIRI near-infrared imager. The image shows the Orion "bullets" as blue features and represents the light emitted by hot iron gas. The light from the wakes, shown in orange, is from excited hydrogen gas. *Gemini Observatory*

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An image released today by the Gemini Observatory brings into focus a new and remarkably detailed view of supersonic "bullets" of gas and the wakes created as they pierce through clouds of molecular hydrogen in the Orion Nebula. The image was made possible with new laser guide star adaptive optics technology that corrects in real time for image distortions caused by Earth's atmosphere.

The Orion Nebula is a star-forming region located relatively near to us, about 1,500 light-years away. It's a young stellar nursery and shows many unusual features related to the effect of massive stars on the dense birth environment of gas and dust.

The Orion bullets were first seen in a visible-light image in 1983. By 1992, images taken at infrared wavelengths led astronomers to conclude that these clumps of gas were ejected from deep within the nebula following an unknown violent event connected with the recent formation of a cluster of massive stars there. The bullets are speeding outward from the cloud at up to 250 miles (400 kilometers) per second. This is more than a thousand times faster than the speed of sound. The name "bullet" is somewhat misleading since these objects are truly gigantic. The typical size of one of the bullet tips is about ten times the size of Pluto's orbit around the Sun. The wakes shown in the image about are about a fifth of a light- year long.

Clouds of iron atoms at the tip of each bullet glow brightly (blue in the Gemini image) as they are shock-heated by friction to around 9,000º Fahrenheit (5000º Celsius). Molecular hydrogen, which makes up the bulk of both the bullets and the surrounding gas cloud, is destroyed at the tips by the violent collisions between the high-speed bullets and the surrounding cloud. On the trailing edges of the bullets, however, the hydrogen molecules are not destroyed, but instead are heated to about 4000ºF (2000ºC). As the bullets plow through the clouds they leave behind distinctive tubular wakes (colored orange in the Gemini image). These wakes shine like bullet tracers due to the heated molecular hydrogen gas.

"What I find stunning about the new image is the detail it shows, which was blurred out in any previous studies, revealing the structure of the bullets and their trailing wakes as they run into the surrounding molecular cloud," said Michael Burton of the University of New South Wales who, along with the late David Allen (Anglo-Australian Observatory) were the first to suggest the origin of these spectacular bullets 15 years ago. "This level of precision will allow the evolution of the system to be followed over the next few years, for small changes in the structures are expected from year to year as the bullets continue their outward motion."

The bullets are relatively young, with their ages estimated to be less than a thousand years since ejection. The new Gemini adaptive optics image shows them in near-infrared light in a combination of three images using different filters. The blue features in the Gemini image correspond to the shocked regions where the iron is fluorescing. The orange regions are the glowing hydrogen molecules in the bullet's wakes. In this image, the wakes ("fingers") behind each of the iron-gas bullets are resolved into filaments for the first time ever. These might well be the actual sheaths enclosing the shock waves created as the bullets travel through the cloud.

The exceptional resolution of the new image was made possible by adaptive optics technology in place at Gemini Observatory. With a laser guide star as a reference and a rapidly deformable mirror for real-time correction, astronomers can compensate for most of the atmospheric distortions that blur the near-infrared image of a star whose light reaches the telescope's primary mirror. The system deploys a yellow/orange solid-state sodium laser that produces the artificial guide star by exciting and causing a small column of sodium gas about 56 miles (90 km) up in our atmosphere to glow. The artificial star it creates becomes a reference star for the adaptive optics system and allows it to determine how the atmosphere distorts the incoming near-infrared starlight.