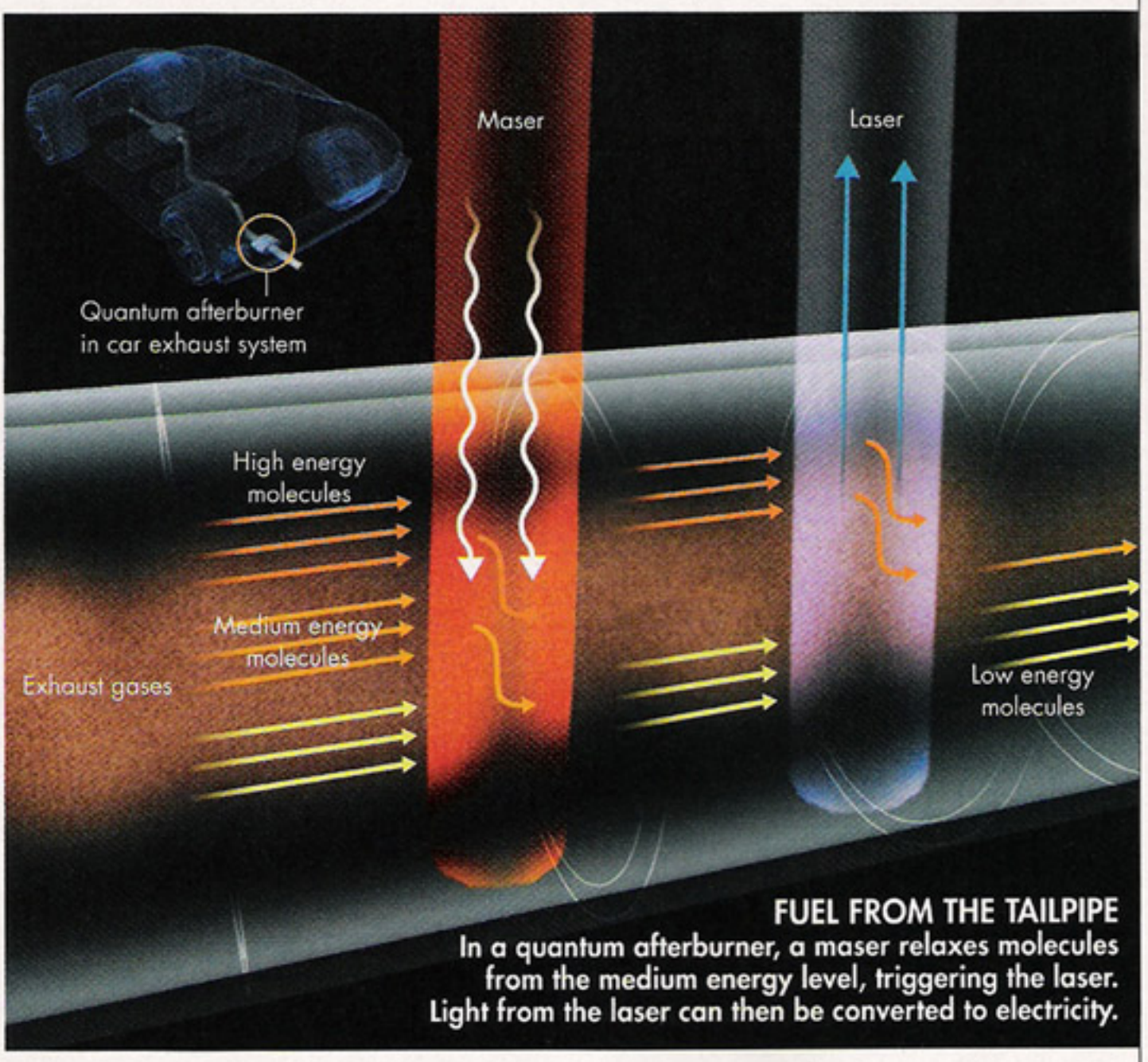


**FUEL FROM THE TAILPIPE**
**In a quantum afterburner, a maser relaxes molecules from the medium energy level, triggering the laser. Light from the laser can then be converted to electricity.**

*engineering*

# POWER WITH SMOKE AND LASERS

## Rethinking the internal combustion engine.

STEAM LOCOMOTIVES, AIRcraft carriers, and weed whackers have one thing in common: They are powered by engines that convert heat into motion.

Unfortunately, such engines are not terribly efficient. But physicist Marlan Scully of Texas A&M University in College Station has a radical idea that could substantially improve them. By adding a laser and a maser (a microwave laser) to an engine, he hopes to squeeze extra energy out of the hot engine exhaust—a "quantum afterburner," as he calls it.

In a typical laser, flashes of light or electricity excite the molecules inside a lasing medium (which can be a gas, liquid, or solid) to high energy levels. This creates a "population inversion"—a situation in which more molecules are in a high energy state than in a low one. Then, as the high energy particles relax (drop to a lower energy level), they emit photons and, consequently, laser light.

In Scully's design, engine exhaust would be the lasing medium. Some of the molecules, heated in the combustion process, are already in an excited state. Others are in medium and low energy states. When they arrive at the afterburner, the maser relaxes molecules from the mid-level, creating a population inversion between the high and medium levels (see graphic). This triggers the laser. The laser light could then be converted into electricity.

Such a device could be built into any type of engine that emits hot exhaust gas. A quantum afterburner in a hybrid gas-electric car, for instance, could boost the auto's battery power. But Scully cautions "this is really still theoretical. We are not doing engineering yet." When researchers are able to put the theory into practice, applications are likely to be on a very small scale. For instance, nanoengines with pistons or turbines could use the technology to pump out electricity, Scully says, and "make it a kind of locomotive"—a very tiny locomotive.—HARALD FRANZEN

GARRY MARSHALL