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Whoosh...Bang! Happy New Year
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For many residents of interior Alaska and points north, the Fourth of July is a frustrating holiday. We can celebrate Independence Day with suitable amounts of noise, but when it comes to Roman candles, rockets, star shells, all those beautiful pyrotechnical devices that illumine skies Outside---we haven't a hope. The sun is too high. But, confident that night will fall, we stock up for New Year's Eve, filling ammunition boxes with supplies to be brought out and touched off months later.

Thus, weather permitting, there'll be a lot of science loose in the sky above Fairbanks as 1990 rolls off the calendar. Oddly, the science part of fireworks is a fairly new thing. Only a handful of families dominated the manufacture of pyrotechnics in the West for generations, and they guarded their knowledge. Little research was done outside those families, and less was reported in public.

The situation now is slightly better. In the United States, only one person teaches classes---several one-week seminars each year---on the subject. John A. Conkling isn't keeping any secrets; he also wrote an article on the physics and chemistry of pyrotechnics for *Scientific American*. (It appeared in a July issue, of course.)

There's a lot of sophisticated chemistry in fireworks color. A white-light emitting device is fueled by a reactive metal, such as magnesium. Heated by the black-powder explosion triggering the device, the metal particles develop a white-hot incandescent glow. If the particles are powder size, the effect is a flash; larger particles produce sparks. Bigger particles lead to sparks that last longer.

If the sparks are gold-colored, they are probably composed of iron and charcoal. Such particles get only half as hot as do particles of reactive metal, so their incandescent color is less intense.

Sparks from a hand-held sparkler are likely to be of that sort, unless it's a colored sparkler. Red sparklers, for example, get their overall color from strontium carbonate. (Most reds in fireworks come from strontium compounds.) The sparks are provided by aluminum granules. The grayish mass covering the unlit sparkler wire contains these ingredients plus fuels, binders, and an oxidizer; even the apparently simple sparkler doesn't represent simple kitchen chemistry.

Sodium is such a powerful source of yellow-orange light that fireworks manufacturers have to use it carefully. Small amounts of sodium contaminating other light-producing ingredients can ruin attempts to generate other colors in a pyrotechnic.

Barium compounds are the source for the different greens in fireworks. They are tricky substances. Barium chloride, for example, is so unstable at typical room temperatures that it can't be packed directly into a rocket or star shell. Instead, the fireworks manufacturers put a more stable chlorine-containing compound (even chlorinated rubber) in with the barium. The compound decomposes at high temperatures and releases free chlorine, which then combines with the barium to create the right light-producing molecules. In effect, the firework has to synthesize its own light source before it can generate light of the desired color.

The sign of a master fireworks maker is a pyrotechnic device that emits a good, bright blue. Copper chloride is the best source yet identified for a rich blue color, but it is unstable at the high temperatures needed to produce bright light in fireworks. Successfully producing blue fireworks takes careful attention to the relative proportions and particle sizes of the necessary chemicals. Strong purple or violet colors are a special challenge, since they combine the emissions from strontium chloride and copper chloride formed right in the flame.

If the kids are awake at midnight on New Year's Eve, tell them all that noise and light comes from successful chemistry experiments. After all, it does.

Fun Science Index Main Index

[Fun Science Facts Index] [Main Index]