LIGHT IN CRYSTALS.

BY A. C. MAURY.

Rays from a sacred ruby are fabled in the Rabbinical legends to have lighted the ark of Noah. The idea of a crystal as a fountain of light has been in all times congenial to the poetic imagination, and nature is less averse to poetry than is sometimes supposed. Many crystals shine in the dark, and some very pretty experiments showing this, may easily be made.

Many diamonds are thus luminous—a property which may enhance in our eyes the value of these precious stones. If rubbed with a woolen cloth or against a hard body, they appear surrounded with light. In particular, the pretty experiment is recommended of rubbing a diamond upon gold, when it shines "like a burning coal excited by the bellows."

Friction, while frequently aiding luminescence, is not its true cause. The essential condition of shining is previous exposure to light. The gem has been lying in the sun's rays, and these it has imprisoned, and now sets free in the dark. The sunbeams of Laputa were stored up in cucumbers; the real sunbeams are more fittingly stowed away in diamonds, and the crystal prison, as though because the light it holds is of no mere earthly fire, goes on shining even under water, like the fairy palace under the sea.

In warm water, indeed, the light becomes brighter, or may be made visible when not otherwise so. We read that in the thirteenth century the alchemist Albertus Magnus saw a diamond which shone when it was put into warm water, and this indicates the early discovery of an important law. In all cases where bodies shine after exposure to the sun, heat hastens the emission of light. It does not increase the total amount of light emitted, for though the body shines more brightly in proportion to the rise of temperature, yet the light lasts a proportionately shorter time. Borrowing a metaphor from coarse material things to describe this truly ethereal phenomenon, it has been said that the phosphorescent body soaks up light like a sponge, and heat squeezes it out.

The effect of friction on phosphorescent diamonds has been proved to be independent of electricity, and may be a modified form of the heat effect. Some facts, however, would seem to render this doubtful, as when Dana, speaking in his "Mineralogy" of the phosphorescence of sulphuret of zinc or blend, says, "Merely the rapid motion of a feather across some specimens will often elicit light more or less intense from this mineral." The effect of friction in disentangling the imprisoned light may therefore appear to be still mysterious.

The property of phosphorescence in diamonds is very capricious. Dr. J. W. Draper, in his Memoir on Phosphorescence, relates that a lady who was a relative had a pair of earrings in which were set two large and beautiful diamonds, both of which he found to be phosphorescent. They shone after exposure to the electric spark, which here took the place of sunlight. She had another pair, and the diamonds in both of these phosphoresced also. Yet in the necklace belonging to this set, containing thirty-eight fine stones, only one was phosphorescent. These were white diamonds. A yellow color would seem more favorable; thus Du Fay found that of four hundred yellow diamonds, all were phosphorescent, while some that were white, rose-colored, blue, or green were not.

We cannot always experiment freely on diamonds, but we may obtain equally beautiful effects with fluorspar crystals, especially those of the variety called chlorophane. A crystal of chlorophane, dropped into water nearly boiling, spreads around it a soft light like that of a glow-worm in the grass on a summer night, delicately tinged with olive green and illuminating beautifully the transparent form of the crystal. Or the fluorspar may, after dark, be placed on the kitchen stove. It soon becomes visible by its pale glow, then brightens till it seems filled to overflowing with the soft green-white light. The reader cannot be advised to try these experiments on his fine cabinet specimens, for, if they be more than slightly heated, they will be cracked and discolored. Ten or twenty cents' worth of broken crystals may be bought of a dealer in minerals, and the following very pretty experiment made:

The pieces are ground in a mortar till some are powdered, others remaining of various sizes. They are then sprinkled on a sheet of iron that has been heated somewhat below red heat in the colorless flame of a Bunsen burner—the experiment being of course done in a perfectly dark room. The fragments begin at once to shine, growing rapidly brighter. They pass through a fine series of color changes, the order of colors varying in different specimens. We may have greenish-white or orange changing to light blue, then rose color, then violet, which, passing through shades of deepening blue, finally becomes dark. The fine powder changes more rapidly than the coarser bits, so that the sheet appears strewn with rainbow colors. Some green fluor used by the writer gave a beautiful effect, the crystal dust turning quickly to an exquisite rose color, while the unbroken rectangular crystals shone like elfin lanterns, casting around a fine illumination, olive-green, orange, or blue.

Colorless or very clear fluor crystals ordinarily shine feebly or not at all; besides the green, the violet and blue generally shine well. Draper had a pale flesh-colored crystal of chlorophane, which excelled all his other specimens in the splendor of its light. It shone of a superb emerald-green color after receiving the rays of the sun. The warmth of the hand in a dark place made it shine. There is no fixed relation between the color of the crystal and the emitted light. At the moment when, after heating, the crystal becomes dark, its color is permanently discharged. There is also decrepitation, on which account it may be well to screen the operator's eyes.

If, in performing the above experiment, the reader grinds the crystals in the dark, he will see that eddies of light follow in the tracks of the pestle. Breaking, scratching, or cleaving a crystal is another mode of eliciting the light it holds thus "veiled in pure transparency." Fluorspar is phosphorescent both on heating and by cleavage; other crystals may be phosphorescent on cleavage, which on heating shine little or not at all.

While cracking up oyster-shells on a block of white marble of the variety called dolomite, the writer was one evening surprised by a flame-colored glow appearing where the dolomite was struck by the hammer. This spot in the white stone shone like a kindled coal, creating the curious impression that the stone was becoming red-hot under the hammer. It was, however, not hot to the touch. The effect was at first supposed to be due to the oyster-shells, which are well known to yield, on calcining, the phosphorescent calcium chloride. It was, however, found that the dolomite, which came from a neighboring quarry at Hastings-on-Hudson, was phosphorescent independently of the oyster-shells. It is well known that some dolomites have this property. A piece of the stone, rubbed with another, or scratched with a sharp instrument, shows in the dark flashes or streaks of fine orange light. Harder pressure or a smart blow of the hammer gives a flame-red glow. The orange streak is nearly instantaneous, but the reddish glow remains a moment before dying out. Pieces of ordinary hard and fine-grained marble do not phosphoresce, and among dolomites the softer varieties with large crystals give the best results.

More lively in its manifestations than this dolomite is a kind of stone found in northern New York and called significantly "hell-fire rock." Any one scratching with a sharp instrument a piece of this sulphurous-looking stone will see, in the dark, the true Mephistophelean fire. The streak is yellow, resembling that of sulphur matches.

The most beautiful exhibition of this kind was made by rubbing together briskly two fine pieces of rose quartz. The crystals, each the size of one's fist, were completely illuminated by brilliant flashes, which shed a light around, rendering the operator's hand visible. The flashes were instantaneous, resembling the illumination from electric sparks. The color of the light was generally white or light yellow, but sometimes the crystals sparkled orange color when their angles struck together and chipped. The experiment was of course most conveniently made by rubbing together broken surfaces of the crystals, so as not to impair handsome specimens. Smoked quartz and other varieties gave sparks as well as the rose.

In making the above experiments, an accident illustrated how it so often happens in the history of science that the investigation of one thing brings another to view. In the dark a finger was inadvertently thrust through a hole in the broken mica chimney of a drop-light, whereupon the bent edges of mica emitted a faint flash of light. The edges of the sheet must be struck obliquely, for it is the cleaving of the thin laminæ of the mica crystals which causes emission of light. It is interesting to note that the separated laminæ possess charges of opposite electricities, although from other evidence we suppose the phenomena of light and electricity independent.

Phosphorescence on cleavage is a property of a number of other crystals. The interesting case of loaf-sugar has been described in a former number of the Scientific American. The most beautiful example of all is said to be the phosphorescence of nitrate of uranium crystals. Each crystal broken in the dark is all lighted up, and provided they are thoroughly dry, it is only necessary to shake up a bowl or bottle of the crystals to cause a splendid display. This is of especial interest, on account of the connection of this substance with the discovery of radium.

Seeing that the shattering of the crystalline bonds causes emission of light, one naturally inquires whether crystals ever give out light in forming. We find that some crystals do, a most beautiful illustration being found in the crystallization of arsenious acid, the common "white arsenic" of commerce. As this experiment requires some laboratory apparatus and as success in it involves careful attention to certain details, it is reserved for a future article. A solution of the substance, properly prepared and set to cool slowly in the dark, sparkles as each tiny crystal forms, while the effect on shaking the solution resembles a fine display of the phosphorescent light at sea.

It is said that molten silver phosphoresces at the moment of solidification, and that water, when made to freeze with great rapidity, emits a flash of light clearly visible in the daytime.

SCIENCE NOTES.

In the report of the Marine Hospital Service of Vera Cruz on yellow fever the announcement is made that the parasite causing yellow fever has at last been discovered. The remarkable work recently done in Cuba by the late Major Reed and his colleagues convicted the mosquito of the spread of yellow fever, and disproved the ancient theory regarding the danger of the so-called formites—clothes, bedding, etc., with which yellow fever patients have been in contact. It was shown that contact with these was quite incapable of causing an attack of yellow fever, but that *Stegomyia fasciata*, a species of mosquito, was almost certainly the sole agent in spreading the disease. This important work was done, despite the fact that the actual cause of yellow fever, the germ, itself was not known. Several previous investigators, including Surgeon-General Sternberg, thought they had found it, but subsequent study disproved this. According to the Vera Cruz commission their microbe is a form of protozoan, similar to the malarial parasite, and not an ordinary bacterium. It goes through a cycle of changes analogous to those of the malarial germ, and its presence in the mosquito modifies the latter's life in a way to favor its spread of the disease.

In a note recently read before the German Physical Society, E. Goldstein presents the results of his experiments on the Giesel emanation body. This body, recently derived from pitchblende, seems to be related to cerium as to its chemical character; it shows emanation phenomena to a very high degree. On account of the small penetration power of this emanation, the author presumed that air would itself exert a strong absorption of the latter, so that its effects would be augmented in exhausted tubes. This hypothesis is borne out by the experiments recorded in the present communication. As regards the question whether the observed luminescence is due either to a gas or simply to a special form of energy issuing from the substance, the experiments of the author seem to be in favor of the latter hypothesis. When cooling exhausted tubes where the active matter had been introduced by means of liquid air, the author observed a very strong luminescence of the wall. This luminescence, so far from arising in the coldest portions of the wall immersed in liquid air, seems to be confined to a zone immediately above the level of the liquid air. This phenomenon is thus characteristic of a definite temperature above the temperature of liquid air. The author next states that the emanation is given off even at the temperature of liquid air; he does not think the emanation energy in question to be identical with that of radium, the mean distinguishing feature being the absence of a coloration of the tubes, and, second, the excessively low penetration.

Last spring Capt. Dana Porter, an American scientist, together with a party, left Mexico for the purpose of studying the Seri Indians on the Tiburon Island. The party has not been heard from, and the State Department at Washington has been unable to learn its fate. From information obtained by a party of Mexican soldiers, sent to the island in search of the scientist and his men, by request of Ambassador Clayton, it seems that the only signs of civilization on the island are some firearms, boats, and a pack of American playing-cards. The first, it is believed, were acquired by the Indians on their trips to the coast of Sonora, or probably belonged to persons who were on the island at the time of the disappearance of the Americans; for the firearms were very old. The boats may have belonged to the Americans. The pack of playing-cards was so new that it may be doubted whether it could have belonged to any member of the last expedition. Ordinary civilized persons could not live on the food of the inhabitants. The food consists of raw turtle, without any condiments, and venison in the same condition. The condition of the native residents of Tiburon Island is absolutely savage, and in appearance, dress, and features they resemble the aborigines of a country of the most remote type. The Tiburon Island is in the Gulf of California. It is thirty miles long and from twelve to twenty miles wide. It is inhabited entirely by the Seri Indians. The island is arid and rugged. Two centuries ago the population of the tribe was estimated at several thousand, but it has been greatly reduced by almost constant warfare to barely 350, of whom not more than seventy-five are adult males or warriors. The Seri men and women are of splendid physique. They have fine chests, with slender but sinewy limbs. They wear long hair, which is tawny in color. The strongest tribal characteristic of the Seri is an implacable animosity toward aliens, whether Indian or Caucasian.