the position of the lines in the spectrum. It is obvious, therefore, that during an exposure of any considerable duration, such as is often necessary with faint spectra, this change of position of the lines due to temperature-change would absolutely destroy the definition on the photographic plate. The shifting of the lines on the plate were found to amount to 0.1 inch for 1° F. An even-temperature box of metal containing cotton was made, and the prism arranged within it. The temperature was regulated by a thermostat contained within the box, consisting of a compound bar of brass and ebonite, which turned on or off the gas as necessary. Afterwards one even-temperature box was placed within another, and it was then found that the temperature could be kept uniform for a long time within 0.1° F., and then the lines did not shift at all so much as the distance between the sodium lines. With this arrangement many hours were taken by the box to settle down to a new temperature, so that, if a change of over 10° F. is to be made in the temperature of the box, it is doubtful whether the spectrum would become stationary in less than twenty-four hours.

The results have a two-fold bearing. In the first place they prove that, by the simple expedient of stirring the liquid in the prism, all striæ may be prevented and the definition rendered perfect. The practical value of this simple expedient is very considerable. The Thollon bisulphide prism, while giving seven-eighths as much dispersion as six flint prisms, gives four times the light in the entire spectrum and eight times the light in the region near G. For photographic purposes, now that the definition can be made permanently sharp and the shifting of the lines prevented, this prism must replace trains of glass prisms, and even gratings, unless these are of large size and are used with telescopes of proportional aperture.

In the second place, this investigation has called attention in a very marked manner to the change in refracting power with change of temperature. This subject has already been discussed by several authors, who agree with the statement of Arago and Neumann, that for glass the law is the reverse of that given for liquids, and that the refractive index increases with the temperature. In the case of the Thollon prism the refractive index increases as the temperature diminishes. As Mendenhall has shown that no change takes place in the angle of the prism with change of temperature, it follows that the observed change of refractive power of the Thollon prism is a differential result due to the excess of the index of the bisulphide in one direction over that of the glass in the other.

It will ever be a source of regret that Dr. Draper did not live to complete the research to which the foregoing investigation was preliminary. With his new and admirably equipped laboratory and with this powerful and thoroughly corrected photographic spectroscope at his command, no one can doubt that he would have secured with it results of the highest value to astronomical, and especially to solar, physics.

PREVENTING COLLISIONS WITH ICEBERGS IN A FOG¹

THE recent accident to the steamer *City of Berlin* emphasises the importance of devising practical methods of ascertaining the proximity of icebergs in a fog. The precautions adopted by Capt. Laud, though they saved the lives of more than 1400 passengers, and prevented serious damage to the vessel, did not prevent contact with the berg. Even the "look-outs" were unaware of the proximity of the iceberg until it was actually upon them.

Under these circumstances the method proposed by

Mr. Frank Della Torre, of Baltimore, deserves consideration. His experiments indicate the possibility of obtaining an echo from an iceberg when in dangerous proximity to a ship. Mr. Della Torre believes that even an object offering so small a surface as a floating wreck may in this way be detected during a fog in time to prevent collision. However this may be, it is certain that his method is worthy of a careful trial at sea, and that preliminary experiments, recently made in the presence of Prof. Rowland, of Johns Hopkins University, and the present writer, have demonstrated the feasibility of producing well-marked echoes from sailing-vessels and steamboats at considerable distances away.

These experiments were made on the River Patapsco, near the head of Chesapeake Bay, at a point about seven miles from the City of Baltimore. The party proceeded down the river in a steam-launch to the selected place, where the distance from shore to shore appeared to be about three miles.

The launch was kept so far from land as to prevent the possibility of mistaking an echo from the shore for one produced by a passing vessel.

The apparatus employed consisted of a musket, to the muzzle of which a speaking-trumpet had been attached. This gun was aimed at passing vessels, while blank cartridges were fired. After a longer or shorter time, according to the distance of the vessel, an echo was returned.

The ordinary river-steamboats, and schooners with large sails, returned perfectly distinct echoes, even when apparently about a mile distant. At shorter distances the effects were, of course, still more striking.

In order to test the effects under the most disadvantageous circumstances, blank cartridges were fired in the direction of an approaching tug-boat. The surface presented was, of course, much smaller than if the boat had presented its broadside to the launch. As the boat approached bow on it corresponded to a target somewhere about six feet square, presenting a convex surface to the impinging sound-wave. Even in this case a feeble echo was perceived when the boat was at a considerable distance (estimated to be nearly one-quarter of a mile). That any echo should have been perceived at all under such circumstances was a surprise. The sound was heard only by the closest attention, but in the case of larger vessels the effects were very distinct and striking.

Experiments were made which demonstrated the fact that the speaking-trumpet attached to the gun was of material assistance in giving direction to the sound-impulse, and in intensifying the audible effect.

Mr. Della Torre claims that a steam-whistle or siren, combined with a projecting apparatus like a speaking-trumpet, will prove as efficient as the gun.

During the experiments on the Patapsco River a curious rumbling effect like the rolling of thunder was often observed, which continued for some seconds. A similar sound was also noticed, as an echo from a well-wooded shore; but the effect alluded to above could not have been due in any way to the land, as the sound commenced immediately upon the firing of the gun, whereas the shore was distant at least a mile or a mile and a half.

The sound was probably due to the presence of ripples on the surface of the water, as the effect was much less marked when the surface was smooth. Such a sound might prove a disturbing element of importance in a rough sea, but would hardly be sufficient to prevent the detection of an echo from a large iceberg. Had shots been fired periodically from the bow of the *City of Berlin* it can hardly be doubted that the presence of an obstacle ahead would have been discovered in time to prevent the collision that actually occurred.

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¹ From *Science*