RADIAL VELOCITIES AND DISTANCES OF THE STARS.—The very puzzling relationship between the linear velocities of the stars and their spectral type has given rise to much speculation. Eddington's suggestion that the relationship is fundamentally between *distance* and velocity received support from the results obtained by Kapteyn for the K-type stars. Dr. W. S. Adams has recently extended the analysis to stars of the other main types (Proc. Nat. Acad. Sci., vol. i., p. 417; also *Astrophysical Journal*, November), with similar results —stars of types F, G, K, and M, having large proper motions, have also high linear velocities. For stars of types B and A the velocity difference is not so marked, but the range of proper motion is also considerably less.

The low average velocity of the distant stars of types F to M—stars of high absolute luminosity—together with the exceptionally great average radial velocity of the observed absolutely faint stars, stars of probably small mass, is held to favour Halm's hypothesis of the equipartition of energy among the stars.

A NEW ASTRONOMICAL PUBLICATION.—Under the ægis of the French Committee of Astronomy there has recently been launched a new periodical, entitled *Journal des Observateurs*. The editorial duties have been assigned to M. Henry Bourget, director of the Marseilles Observatory. The journal is to be strictly and exclusively devoted to the publication of observational matter concerning—for the present—planets and comets. The first number contains series of observations of comet Mellish (1915*a*), from Lyons, Algiers, and Marseilles, together with observations of minor planets. Numbers are to be published as occasion demands, and the terms of subscription are 25 francs per volume of twenty parts. We wish the new venture every success.

LANCASHIRE SEA-FISHERY INVESTIGATIONS.

NOTWITHSTANDING the fact that investigations at sea practically ceased with the outbreak of war, the report of the Lancashire Sea-Fisheries Laboratory for 1914 shows that much useful work was still carried on under the more restricted conditions which the war imposed. As Prof. Herdman points out in his introductory chapter, the present seems an opportunity to concentrate attention upon the cultivation of the shallower seas, and any increase of employment on the seashore or in shallow waters may be of direct and immediate advantage, both to the fishermen and to the country. "Such industries as shellfish cultivation, shrimping and prawning, whitebait and sprat fishing, if extended and exploited judiciously, will add to employment, will increase the food supplies of the country, and may lead to the establishment of permanent industries of a profitable nature."

One of the most useful sections of the report is the memoir by Dr. James Johnstone on the bacteriology of shellfish, which records the results of experimental work on the methods of cleansing mussels from ingested sewage bacteria. The self-cleansing of sewage-polluted mussels by placing them for some days in pure sea-water had previously been demonstrated. The experiments now described deal (1) with the periodic bacteriological examination of mussels from a polluted source, which were laid down either on the shore or in floating tanks in localities where pure sea-water is found; and (2) with similar bacteriological examination of mussels from a polluted source which were kept in sea-water sterilised by the addition of five parts in a million of chlorine. In both cases the number of organisms in the mussels was so far reduced that the shellfish might be safely used as food.

In an appendix to the memoir, Dr. Johnstone gives a more minute and detailed examination of the scientific methods employed in his investigations and of the principles involved, which will be greatly valued by specialists in this line of work.

A second memoir by Dr. Johnstone deals with diseased and abnormal conditions of marine fishes, and forms a substantial addition to his previous work on this subject. The greater part of the memoir is devoted to the description of tumours found in fishes. Both benign and malignant tumours occur, the malignant being rare. All the malignant tumours the author has seen in fishes are sarcomata, due to an excessive growth of connective-tissue and almost always of the subintegumentary connective-tissues. Cases of hæmangioma in the eye of a stickleback and of papillary cystadenoma in a ling are also described.

A paper of high scientific value is that by Prof. B. Moore and Messrs. E. B. R. Prideaux and G. A. Herdman, entitled "Studies of Certain Photo-synthetic Phenomena in Sea-water." In this paper, seasonal variations in the reaction of sea-water in relation to the activities of vegetable and animal plankton are investigated and discussed. It is shown that the alkalinity of the water in the Irish Sea increases in the spring and summer months. This increase in alkalinity is not due to increasing temperature disturbing the equilibrium between the carbon dioxide of sea-water and atmosphere, for the rise in alkalinity clearly precedes in time the rise in temperature. It is caused, the authors state, by photo-synthesis, as is shown by its coincidence in its occurrence with the rapid lengthening of the day in March and the increasing sun's altitude, as also by the great changes in alkalinity which may be produced by exposure of sea-water containing algæ to sunlight.

Other subjects dealt with in the report are the plankton of the Irish Sea, the spawning period of the common shrimp, the whitebait fisheries of the Menai Strait, measurements of the Irish Sea race of herrings, and the variations in the amount of fat in these herrings at different seasons. The report as a whole shows that much valuable work is being carried out, and the Lancashire Sea-Fisheries Committee is to be congratulated upon it

THE ACTION OF GASES ON IRON AND STEEL.

BY a curious coincidence, three out of the eight papers presented at the recent autumn meeting of the Iron and Steel Institute deal with the effects of a gas or its compounds when present in iron or steel. The gases dealt with are oxygen, by Mr. Wesley Austin; nitrogen, by Prof. N. Tschischewski, of Tomsk; and blast-furnace gases, by Mr. T. H. Byrom. The prominence thus given to the question of the action of gases reflects the increasing attention which this subject demands in practice. During most ordinary manufacturing processes our metals are exposed—often for prolonged periods—to the action of gases, and a knowledge of their action is thus of great importance. The subject is, however, beset with difficulties, since in many cases it is not at all easy to prepare alloys containing a given gaseous element in any desired proportion, while even the analytical determination of the nitrogen or oxygen contents of steel is by no means free from doubt and difficulty.

These difficulties are evident in the two papers named above, which deal with oxygen and nitrogen. Mr. Austin's specially prepared "oxygen alloys" contain relatively very large amounts of oxygen, and this makes it difficult to bridge the gap between his laboratory series and even the most highly oxygenated steels met with in practice. The same difficulty occurs in regard to Prof. Tschischewski's paper, which does not, therefore, set at rest the vexed question whether the very minute quantities of nitrogen which are found in industrial steels—and particularly in those made by the Bessemer process, are really responsible for the injurious effects which are sometimes ascribed to them. It was therefore satisfactory to hear that the whole question of the influence of nitrogen was to be placed on a more satisfactory basis by systematic research under the auspices of Dr. J. E. Stead. Meanwhile, the results of the Russian investigator furnish the best available data in regard to nitrogen in steel. In order to introduce nitrogen into steel, Prof. Tschischewski found it necessary to expose the heated metal to ammonia vapours, since free nitrogen apparently does not combine with iron except, possibly, at very high temperatures. Incidentally, this result is of importance from the point of view of experiments on iron and its alloys at moderately high temperatures, since it indicates that an atmosphere of pure nitrogen would be without action on the material.

Interesting from what is, at first sight, an entirely different point of view, are the results obtained by Mr. Byrom in his observations of the carburising action of blast-furnace gases at temperatures not exceeding 500° C. Hitherto it has been generally held that the carburisation of iron does not take place until the temperature of Ac_1—about 700° C.—is exceeded. The explanation given has been that since iron carbide is not soluble in alpha iron, which can alone exist at such lower temperatures, carburisation would not occur, or, if it did, must remain strictly confined to the surface. Mr. Byrom, however, with the co-operation of Dr. Stead, has shown that in the stream of gases which come from a blast-furnace, iron becomes rapidly carburised, and is, in fact, converted into a carbide of iron so rich in carbon that the presence of a carbide, Fe_2C, in addition to the well-known Fe_3C is suspected. There is, however, a simultaneous increase in the sulphur-content of the material.

The contradiction between these observations and the previously accepted views is not so great as at first sight appears. An examination of the iron after partial carburisation by these gases at once shows that there really is no diffusion of the carbides through the iron, but that the carbide is formed *in situ* by the interaction of the gas, which has diffused through the iron as such, and the iron immediately in contact with it. It is, further, very doubtful indeed, if it has not actually been disproved, whether any such carburising action would occur if the blast-furnace gases were replaced by pure carbon monoxide; it is almost certain that some of the other gases present in the blast-furnace, such as the carbon oxy-sulphide which Mr. Byrom suggests, play an important part in the reaction as "catalytic agents."

This consideration also affects a theoretical bearing to which attention was directed by Prof. Carpenter in the discussion on Mr. Byrom's paper. The point in question is that of the supposed "meta-stable" character of iron carbide. This conception of the nature of the carbide, and its tendency to dissociate into free carbon and iron, lies at the base of the widely accepted equilibrium diagram of the iron-carbon system. If, however, it could be shown that iron and carbon could unite to form iron carbide at these moderate temperatures, then the idea that the carbide is meta-stable at these temperatures would have to be abandoned. As was pointed out by Dr. Rosenhain, however, the results obtained by Mr. Byrom do not at all establish such a fact; all that they do establish is that in the complex system consisting of iron, carbon monoxide, and a number of other gases, iron carbide can be formed at temperatures in the neighbourhood of 500° C. But it is quite possible, and even probable, that the equilibrium ranges of such a substance as iron carbide may be very considerably altered in the presence of three or more components. The fact that the presence of another component does frequently alter or depress the lines or surfaces of equilibrium in a thermal diagram is well known, and it may be that what is frequently termed "catalytic action" is simply due to such an effect. Therefore, although interesting and important in themselves, Mr. Byrom's results appear to leave the question of the stability or otherwise of iron carbide much where it was before.

The two papers on the nitrogenisation and the carburisation of iron brought out one common feature of great interest. In both it was shown that the gases penetrated along the boundaries of the crystals of the metal and from these spread into the masses of the crystals along the cleavage planes. Both the carbide and the nitride of iron exhibit the distribution typical of such action most clearly—so much so that attack by means of gases would seem to offer possibilities for the study of the crystallographic data of the material by rendering visible certain cleavage planes.

The phenomenon is, however, interesting in itself, and demands explanation. Such an explanation was offered in the discussion, on the basis of the "amorphous cement" hypothesis of Dr. Rosenhain. If the crystals are held together by thin layers of amorphous metal, then these layers would naturally serve as channels for the diffusion of gases. Liquid metals are well known to possess greater powers of dissolving gases than the solid material, and the "amorphous" condition is at all events closely akin to the liquid phase, even if it is not entirely identical with it. Even iron carbide would be soluble in the amorphous layers, and its distribution along the crystal boundaries would thus be readily explained. On the cleavages also, traces of amorphous metal might well be left as residues of the amorphous metal which would—according to the views of Beilby and Rosenhain—be formed on those planes whenever the metal was "wrought." It will be seen that these results of experiments on the action of gases throw an unexpected sidelight on a theory which is still the subject of controversy; they even suggest the possibility of employing gases as "reagents" for the detection and location of any amorphous metal which may be present in a specimen.

Finally, it should perhaps be stated—although it is obvious enough—that the results contained in these papers are of some considerable practical importance, but in this place they have been regarded rather from the point of view of scientific interest.

SCIENCE AND CIVILISATION.[1]

THE San Francisco meeting has been appointed with the double purpose of encouraging the development of science in the Pacific region and of uniting with other organisations in celebrating the completion of the Panama Canal. There could scarcely be a better illustration of the relations of science to civilisation than the canal supplies. This great waterway has been constructed, not so much by the potency of our national wealth in gold, not so much by the wonderful engineering and administrative ability which we all delight to honour, as by the victory of pure and applied science over the sources of malarial and yellow fever infection. Three centuries

1 Address (slightly abridged) to the American Associati n for the Advancement of Science, delivered at the San Francisco meeting, August 2, by the President, Dr. W. W. Campbell.