tions, the character of the formulæ for determining the es­tablishment, the semimenstrual inequality, the corrections for lunar and solar parallax and declination, both as affect­ing the times and the height of high water. His papers on the “ Empirical Laws of the Tides of the Port of Liver­pool,” and on the “ Solar Inequality and Diurnal Inequali­ty” of the tides at the same place, are full of valuable sug­gestions, which the subsequent investigations of Mr Lub­bock have in some cases very remarkably confirmed and extended. Several of the last of Mr Whewell's papers re­late to the constancy of the half-tide level, and the diurnal inequality of the heights and intervals of the times of the tide. The discussion of the Liverpool observations had exhi­bited this last, though under circumstances much less strik­ing than those which characterize its appearance at other places, as will be noticed more particularly afterwards. His first memoir on this subject relates to the diurnal in­equality at Plymouth and Sincapore ; at the last of which places its magnitude is very remarkable, making a difference of not less than six feet in the height of the morning and evening tides, and quite sufficient to obliterate, under cer­tain circumstances, one of the semidiurnal tides, and ex­plaining certain peculiarities in the phenomena which have hitherto been considered as cases of interference.

The researches of Mr Lubbock and Mr Whewell on the tides, and their discussions of the observations made at va­rious ports, have now reached such an extent as to be dis­tributed through ten successive volumes of the Phil. Trans. (1831-1840). Some shorter articles have been also pub­lished in the Reports of the British Association, and ab­stracts in the Philosophical Magazine and other journals. Mr Lubbock has besides published a small Elementary Treatise on the Tides. Before these gentlemen took up the subject, which they have done with great credit to them­selves and advantage to the public, the theory of the tides, though little cultivated and little known, was in advance of observation. Tide-tables were constructed by unpublish­ed rules, which, though generally very imperfect, formed a profitable possession to those to whom they were known ; and the distinctive characters of the tides in the different ports of this kingdom, that of Liverpool perhaps excepted, were confined to the experience and tact of those who were accustomed to use them ; but how different is the case at present. The rules for the construction of tide-tables are not only public property, but are based upon the most ex­tensive observations ; laws whose existence was hardly sus­pected, are now distinctly laid down ; the progress of the waves in the most frequented parts of the ocean is begin­ning to be accurately developed ; theory, which formerly was in advance of observation, though greatly improved in those parts of it which do not involve the hydrodynamical laws of the ocean, is now greatly behind it ; and such a basis of facts has been laid down as may enable the mathematician to commence such a series of investigations as may termi­nate in enabling some one to give to the theory of the tides a form more closely resembling, in the certainty of its pre­dictions, the almost perfect theory of physical astronomy.

Mr Lubbock and Mr Whewel) have, among other sub­jects, treated at considerable length on the causes of in­accuracy in tide records and observations. We shall here endeavour to notice the chief of these ; and it will serve two purposes if we give a popular account of them, in con­nection with the principal empirical corrections which these gentlemen have found requisite to compensate for the va­rious inequalities of tidal phenomena. On comparing the times of the tide at different places, as hitherto stated by the best authorities, we find very many cases which seem quite incompatible with any notion of obvious continuity and simple laws prevailing in this class of facts. For in­stance, if the time of high water at Plymouth were five o’clock, and at Eddystone eight, as usually stated, the water must be falling for three hours on the shore, while it is rising at ten or twelve miles distance, and this through a height of several feet. It is difficult to conceive how any elevation at the one place should not be transferred to the other in a much shorter time. In fact, eight o’clock, in­stead of being the time of high water at Eddystone, is the time of slack water, or when the current changes. Thus there is reason to think tl>at very many, if not the whole, of such inconsistencies have originated in confounding two different phenomena, namely, the time of high water, and the time of the change from the flow to the ebb current. In some cases the one, and in some cases the other, of these times has been recorded as the hour of the tide. The time of slack water, or of the change of current, only coincides with the time of high water very near the shore, and with­in its influence, and especially in harbours which have only one opening. The difference between these times is gene­rally considerable, and great confusion has arisen from not properly distinguishing between them. The persuasion, that in waters affected by tides, the water always rises while it runs one way, and falls while it returns in the opposite direction, though very erroneous, has long been quite ge­neral. For example, it has been usual to state that the time of tide in the British Channel must be three hours later in the mid sea than near the shore, because the cur­rent continues running eastward three hours after the time of high water on the coast. Many instances could be given of the perplexities which have arisen from this assumption.

The times most usually recorded as the tide-hours for different places, are those of the tides on the days of new and full moon ; which times are often called the establish­ments of the places to which they belong, and are supposed to regulate the times of the tide on all other days of the lunation, because the tide is primarily governed by the moon. This, however true as a first approximation, assumes that the tide always occurs at the same hour-angle from the moon. But the hour of the tide on any day expresses its hour-angle from the sun ; and as the moon changes her right ascension by about forty-eight minutes every day, the observed hour of the tide being given on the day of full and new moon, the hour-angle from the moon may be different according to the time of the day when the conjunction takes place, com­pared with the time of the observed tide. Thus, if the con­junction take place at one o’clock in the morning, and the observed tide at eleven at night, the distance of the tide from the sun is eleven hours; but at eleven at night the moon is to the east of the sun by her motion in twenty-two hours, which is forty-four minutes of hour-angle, and there­fore the tide is only ten hours sixteen minutes behind the moon. But if the observed tide occur at one in the morn­ing, and the conjunction at eleven at night, the moon, at the time of the tide, is forty-four minutes to the west of the sun, and the tide occurs at one hour forty-four minutes. In the former case the establishment is forty-four minutes less, in the latter forty-four minutes more, than the observation of the hour of the tide gives it. If the observed hour of tide were six in the evening, and the conjunction occurred at one in the morning, the true establishment would be 5h. 26m; but if the tide be at six in the morning, and the conjunction at eleven at night, the true establishment will be 6h. 34m. Thus, an observation of the hour of the tide on the day of new or full moon leaves an uncertainty of at least 1h. 8m. as to the establishment, if we do not take into account whether the morning or afternoon tide was observ­ed, and at what hour the conjunction or opposition of the moon took place. Besides, the time of high water may often be doubtful to the extent of ten or fifteen minutes, from inaccuracy in the observation ; and as this error may occur in opposite directions at two different observations, and may be combined with that of the observation just men­tioned, we may thus have two establishments, differing above