Whenever the courſe lies ſo far from the wind that it is poſſible to make the tangent of the apparent angle of the wind and sail double the tangent of the sail and courſe, it ſhould be done.

Theſe are the chief practical conſequences which can be deduced from the theory. But we ſhould conſider how far this adjuſtment of the ſails and courſe can be performed. And here occur difficulties ſo great as to make it almoſt impracticable. We have always ſuppoſed the poſition of the ſurface of the ſail to be distinctly obſervable and meaſurable; but this can hardly be affirmed even with reſpect to a ſail ſtretched on a yard. Here we ſuppoſed the ſurface of the ſail to have the ſame inclination to the keel that the yard has. This is by no means the caſe; the ſail affirmes a concave form, of which it is almoſt impoſſible to aſſign the direction of the mean impulſe. We believe that this is always conſiderably to leeward of a perpendicular to the yard, ly­ing between CI and CE (fig. 6.). This is of ſome ad­vantage, being equivalent to a ſharper trim. We can­not affirm this, however, with any confidence, becauſe it renders the impulſe on the weather-leech of the ſail ſo exceedingly feeble as hardly to have any effect. In ſailing cloſe to the wind the ſhip is kept ſo near that the weather-leech of the ſail is almoſt ready to receive the wind edgewiſe, and to flutter or driver. The moſt effective or drawing ſails with a ſidewind, eſpecially when plying to windward, are the ſtayſails. We be­lieve that it is impoſſible to ſay, with any thing ap­proaching to preciſion, what is the poſition of the general ſurface of a ſtayſail, or to calculate the intenſity and direction of the general impulſe; and we affirm with confidence that no man can pronounce on theſe points with any exactneſs. If we can gueſs within a third or a fourth part of the truth, it is all we can pretend to; and after all, it is but a gueſs. Add to this, the ſails coming in the way of each other, and either becalming them or ſending the wind upon them in a direction widely different from that of its free motion. All theſe points we think beyond our power of calculation, and therefore that it is in vain to give the ſeaman mathema­tical rules, or even tables of adjuſtment ready calculated; ſince he can neither produce that medium poſition of his ſails that is required, nor tell what is the poſition which he employs.

This is one of the principal reaſons why ſo little ad­vantage has been derived from the very ingenious and promiſing diſquiſitions of Bouguer and other mathe­maticians, and has made us omit the actual ſolution of the chief problems, contenting ourſelves with pointing out the proceſs to ſuch readers as have a reliſh for theſe analytical operations.

But there is another principal reaſon for the ſmall progreſs which has been made in the theory of ſeaman- ſhip: This is the errors of the theory itſelf, which ſuppoſes the impulſions of a fluid to be in the duplicate ra­tio of the ſine of incidence. The moſt careful compariſon which has been made between the reſults of this theory and matter of fact is to be ſeen in the experi­ments made by the members of the Royal Academy of Sciences at Paris, mentioned in the article RESISTANCE *of Fluids.* We ſubjoin another abſtract of them in the following table; where col. 1ſt gives the angle of in­cidence; col. 2d gives the impulſions really obſerved; col. 3d the impulſes, had they followed the duplicate

ratio of the ſines; and col 4th the impulſes, if they were in the ſimple ratio of the ſines.

|  |  |  |  |
| --- | --- | --- | --- |
| Angle  of  Incid. | Impulsion  obſerved. | Impulſe  as  Sine2. | Impulse  as  Sine. |
| 90 | 10OO | 10OO | 10OO |
| 84 | 989 | 989 | 995 |
| 78 | 958 | 957 | 978 |
| 72 | 908 | 905 | 951 |
| 66 | 845 | 835 | 914 |
| 60 | 771 | 750 | 866 |
| 54 | 693 | 655 | 809 |
| 48 | 615 | 552 | 743 |
| 42 | 543 | 448 | 669 |
| 36 | 480 | 346 | 587 |
| 30 | 440 | 250 | 500 |
| 24 | 424 | 165 | 407 |
| 18 | 414 | 96 | 309 |
| 12 | 406 | 43 | 208 |
| 6 | 400 | **11** | 105 |

Here we ſee an enormous difference in the great obli­quities. When the angle of incidence is only ſix de­grees, the obſerved impulſe is forty times greater than the theoretical impulſe; at 12⁰ it is ten times greater; at 18⁰ it is more than four times greater; and at 24⁰ it is almoſt three times greater.

No wonder then that the deductions from this theory are ſo uſeleſs and ſo unlike what we familiarly obſerve. We took notice of this when we were conſidering the leeway of a rectangular box, and thus ſaw a reaſon for admitting an incomparably ſmaller leeway than what would reſult from the laborious computations neceſſary by the theory. This error in theory has as great an in­fluence on the impulſions of air when acting obliquely on a ſail; and the experiments of Mr Robins and of the Chevalier Borda on the oblique impulſions of air are perfectly conformable (as far as they go) to thoſe of the academicians on water. The oblique impulſions of the wind are therefore much more efficacious for preſſing the ſhip in the direction of her courſe than the theory allows us to ſuppoſe; and the progreſs of a ſhip plying to windward is much greater, both becauſe the oblique impulſes of the wind are more effective, and becauſe the leeway is much ſmaller, than we ſuppoſe. Were not this the caſe, it would be impoſſible for a ſquare-rigged ſhip to get to windward. The impulse on her fails when cloſe-hauled would be ſo trifling that ſhe would not have a third part of the velocity which we ſee her acquire: and this trifling velocity would be waſted in leeway; for we have ſeen that the diminution of the oblique impulſes of the water is accompanied by an increaſe of leeway. But we ſee that in the great ob­liquities the impulſions continue to be very conſiderable, and that even an incidence of ſix degrees gives an impulſe as great as the theory allows to an incidence of 40. We may therefore, on all occaſions, keep the yards more ſquare; and the loſs which we ſuſtain by the dimi­nution of the very oblique impulſe will be more than compenſated by its more favourable direction with re­ſpect to the ſhip’s keel. Let us take an example of this. Suppoſe the wind about two points before the beam, making an angle of 68⁰ with the keel. The theory aſſigns 43⁰ for the inclination of the wind to