Thornlea,
Trumpington Road,
Cambridge.

15/98

11 Feb. 1895.

Dear Fitzgerald

You have doubtless heard that Boltzmann's letter in <u>Nature</u> which will probably be out this week is to be a final decision as regards the present discussⁿ & is to be the last letter in Nature for the present.

With regard to the two conditions you name, I do say that (a) in cases

---

of their neighbours and so on, so that we cannot find any assemblage of molecules (which are isolated from the action of all the rest) we have a condition which <u>baffles most investigations</u> - You have probably seen Burbury's recent attempts to deal with crowded molecules just read before the Royal Society ~~but it is so~~ which seem to suggest that it is very doubtful how far ~~in conclusions~~ the Boltzmann Maxwell distributⁿ applies to solids & liquids*. I quite agree that the unsatisfactory part of the

*Thus, for aught we know at present, the solution of the difficulty may lie in conditⁿ (b) of your letter as you think & this is a <u>most promising direction</u> to seek for it

where (as in a small number of bodies such as the members of the solar system) all possible motions are not simultaneously represented, we cannot apply the statistical method. Where we have to deal with a small number of bodies like the planets, we can work their motions out exactly and of course cannot, and do not want to, infer the probability of the any particular distribution of energy from any law of averages because we know the actual distribution at every instant – Is it not as if we were to try to make statistical calculations as to the death rate in a community consisting of half a dozen inhabitants This would be too small a number for the observations to be of much value in predicting how often a death would take place. ~~Such such a limitation~~ It is only when we have a population of some thousands to deal with that we can assert any definite law as to the average number of deaths occurring every year, and the greater the population the less deviation should we get from the ~~more exactly should we get~~ an average. But this condition does not seem to apply to solids liquids or the ether &c &c.

As to condition (b) We say that if one molecule acts on a large number of its neighbours, these again act on a large number

15/98

construed the opposite way – this is such a difficult subject to make one's meaning clear in. As regards using generalized coordinates in this work, that enables us to deal with the translatory & rotatory energy of molecules & put the equations into a simpler form than if we were to use Cartesian methods. I have not Watson's book here but there is one determinant in it, depending on u, v, w, λ_1, λ_2, λ_3 &c which he finds out in an elaborate way & then shows that it comes down to be equal to unity (quite by accident as it appears) whereas if he had used generalized coordinates he would have seen that this is a necessary consequence of the simple properties of Jacobians and not a mere matter of chance –

With kind regards

Yours sincerely

C V Boys.

K. Theory is that it does not go far enough & think that the medium of crowded molecules does gives us quite a big enough fortress to concentrate our artillery on for the present. I don't know that my opinion is really different from yours except in thinking that we may be excused from having anything to do with the ether until we have got more definite means of attack at our disposal.

15/98

As regards the ~~globes~~ spheres moving in liquids of course there is

a distinction between perfect & viscous liquids – If a sphere is moving thro' a viscous liquid the liquid will in time absorb all the energy, whereas if it moves in a perfect liquid the energy of the liquid will only be a certain fraction of that of the solid – Since we know that matter (such as the heavenly bodies) – can move through the ether without suffering appreciable retardation that seems to suggest that ~~as~~ in this one particular the ether behaves like a perfect rather than a viscous liquid and that the law of distribut^n of translatory & ~~such~~ rotatory energy among the molecules of a gas may be independent or unaffected by the presence of the ether.

15/98

~~When you~~ In what you say "that the simple cases sh^d be worked out first & these grand generalisations left until we can approach them gradually" – has not this been rather the point of what little I have said on the matter? I have intended to emphasize this but perhaps what I said in my Report has been