November 17, 1970

Dear Dick,

Thanks for your letters of November 5 and 6. The former first:

You object to my explanation of the fact that, ceteris paribus, small fragments do not travel as far as large ones. First, you seem to think that I was putting down your discussion of this point by calling it a "naive physical argument." In fact, I gave that description to my explanation, not yours (page 15, lines 9 ff. of the Supplement). Also, to mathematicians and physicists, "naive" has no negative connotations. I presented a partial description of the retarding forces, just enough to allow me to extract the general dependence of penetration distance on the size of the particle.

Although I did not want to get into the details of your explanation of this phenomenon (page 5 of your letter of October 11), I assure you that it should not persuade anyone. Arguments of that nature are very convenient for providing a comforting understanding of behavior that has been established; in this case, you are certainly justified in using it to feel that you understand what is going on. But, on the basis of years of experience with such arguments, I emphasize that one can make incorrect results seem just as plausible as correct ones. (Try it sometime.) Such an argument has no value as proof. As I'm sure you know better than I, lots of the scientific arguments that occupied philosophers before experimental approaches were adopted seemed quite plausible - arguments about how many angels could fit on the head of a pin, why heavy objects fall faster than light ones, etc. If you expect your expertise in ballistics to be taken seriously, it does not behoove you to ridicule as "jibberish" a simple explanation which should be comprehensible to anyone with a basic knowledge of the physics of moving bodies.

I have been doing quite a bit of reading in wound ballistics, and have discussed this matter with a faculty member in criminalistics; at this point I will stand by my assessment of your theory as stated in the Supplement.

You again assert that the mere presence of the dust-like fragments only in the right front of the head is conclusive in itself. The truth or falsity of that statement in not affected by your confidence in it or the number of times you repeat it.

The question of the direction of the cluster is not an "unwarranted diversion." As I discussed in the Supplement, the autopsy and the Review panel present significantly different descriptions of the fragment distribution. One cannot reasonably say that all the evidence locates dust-like fragments only in the right front, unconnected with the back entry hole. If you want to claim that you are being reasonable on this point and that I am not, go right ahead, and we needn't discuss it further.

As for your argument that you can't have dust away from the point of origin and not all along the path (bottom of page 1): may I ask how you came up with the statement that the fragments "move as a cloud, as smoke, as a liquid spray, and they adhere to everything they touch"? Is this supposed to be self-evident? Could one not just as plausibly say that they move like little bullets, tearing their way through the tissue for some considerable distance until their energy is lost? Are you reporting an empirical fact? If so, report it, and describe your evidence; if not, don't bother to tell me what "cannot" happen.

Page 2, middle: I've read this over several times and I still don't see your point. Why do you say that "either the fragment bursts before it reaches the front, or it does not burst at all"? I already told you that I would not be surprised if frictional forces broke off small fragments at various points along the path. The frictional forces are, after all, strong enough to slow down large fragments continuously. We know that detectable amounts of copper from the jacket can come off on clothing; why is it so hard to believe that dust-like fragments of the softer core can come off in tissue?

cc: Weisberg, Roffman, Schoener, Newcomb,
Neagher, Thompson, Nichols, Wecht.

I remind you again that the Commission's hypothesis requires the deposition of small fragments from a larger chunk of a jacketed bullet. The conditions under which that may happen need not be the same as those for the complete bursting to dust of either a jacketed or a unjacketed bullet. It's that simple.

Among all your assertions that this is all very simple I can find only one hint of an argument - that other fragments in the head appear not to have shed dust-like fragments in that fashion. Of course I had thought of that, and I stand by my opinion that we do not have adequate information on whether the other fragments did or did not in fact do that, and that the various fragments had different shapes, sizes, speeds, etc. and would not have to behave in the same way.

You allege that the statements on medical matters "seem inconsistent only to those who seek to find in them evidence that JFK was struck in the head only from behind." You say that I "falsely assert that the medical evidence is inconsistent." Incredible! I pointed out that the medical statements are inconsistent with each other. What else does "inconsistent" possibly mean? How can you call this either false or irrelevant, especially when the descriptions are inconsistent with regard to the small fragments, and you choose to disregard the autopsy doctors' version completely?

I accepted your statement that the penetration of fragments in tissue is smaller for small fragments. (I have now found confirmation, at least for projectiles of millimeter size and larger.) I said that this proves that the small fragments were created near where they came to rest. That was an incorrect overstatement: I should have said that they passed through only a small amount of tissue before stopping. This is not just a quibble. I understand that typically a projectile in tissue opens up a temporary cavity much larger than the projectile, and much larger than the permanent path that is visible upon dissection. (I can't prove that the formulas derived on the basis of projectiles of velocity 1500 fps and up also hold for lower speeds, but they give, for a 2-grain steel sphere, i.e. with radius 0.125 inches, traveling at only 500 fps in tissue, a cavity 3.4cm in diameter! That's quite large.) These temporary cavities survive for a time on the order of milliseconds. If fragments are sloughed off near the point of entry, some of them could travel along behind the bullet, in the temporary cavity, for some distance, without encountering any stopping material. I'm not saying this has to happen, but it seems quite possible. You seem to have considered something like this (on page 6 of your letter of Oct. 11, 2nd paragraph); why do you say that such fragments "will not go far"?

The photo you sent does show that small fragments penetrate less than large ones, for the relatively large fragments visible in the picture. One can not automatically extrapolate this behavior to the dust-like fragments. To see if jacketed bullets give off dust-like fragments along the path of major fragments, it would probably be sufficient to fire several tests shots into 20% gelatin gel through a piece of masonite or the like to break the bullet up, at least into a few large chunks. I'll try to arrange to do this here; it might be easier for you.

As I previously indicated, it would be necessary to X-ray the bullet path to pick out the small fragments. It is obvious that when one slices across the path in a non-transparent medium, only a fraction of the secondary fragments are exposed, and that fraction is smaller for smaller fragments. You can easily (I hope) repeat my calculation that for spherical fragments of diameter d scattered uniformly along a path of diameter D, a slice through the center of the path touches (i.e., exposes) only a fraction $f = (4/\pi)(d/D)$ of the fragments. If the fragments are distributed only in a cylindrical shell enclosing the bullet path, the fraction exposed is even smaller: $f = (4/\pi)(d/D_1+D_2)$, where D_1 and D_2 are the outer and inner diameters of the shell. For fragments with d=0.2 mm in a path with D=6.5 mm, this means that only about 4% at most will be visible in a slice; thus, an X-ray and a photo would look quite different.

I will correct page 20 of the Supplement to remove the implication that any high-velocity or high-mass bullet is "special." You make a big point of the fact that I ignored the listing of these bullets in your letter of 10/23 to Harold. In that letter you did not give the velocity of the bullets, so I could not tell it their momenta are great enough to account for the backward momentum observed in the Zapruder film. From the data in your letter of 11/5, I note that the muzzle momentum ranges from 1.6×10^5 grains-feet/second for the .222 Remington to 3.7×10^5 for the .264 Winchester Magnum. For the 6.5 Carcano (mass = 160 grains, mezzle velocity = 2165 fps), the muzzle momentum is 3.48×10^5, only about 10% less than the greatest momentum for the bullets you list. In foot-pounds/sec, the muzzle momentum is 53 for the .264 Magnum; at 100 yards, from your figures, it is down to 47. Recall that my crude estimate of the backward momentum of JFK ranges from 32 to 96; taking into account the leftward motion would increase the extimate, perhaps by as much as 50%. I pointed out that the magnitude of the recoil compared to that of the Carcano bullet is a good argument that the jet recoil hypothesis has not been established. (Supplement, pp. 6-7) Similarly, if my "high" estimate is correct, a front shot would require even more incident momentum than that of the most powerful of the bullets on your list. (Unless, of course, a recoil-like or neurological cause for the motion is invoked.) As you know, there is difficulty with the "kick" of a very high-momentum bullet, which interferes with aiming. Do you have any information on projectiles of even higher momentum that those you listed, "special" or otherwise? (One of the things I had in mind was a rifle that fires small rockets which I recall reading about.)

Page 7: the only objection I set forth to your argument was, indeed, that it may be wrong. Would you care to justify the last sentence of your second paragraph? My ballistics and criminalistics expert warned me, unsolicited, that ballistics is an empirical science and that theorizing about questionable observations is very risky.

On to your letter of 11/6: thank you for telling me about the analyses you refer to by the Eastern pathologist, concluding that the rear head shot was not a fully jacketed bullet. Until I see his case, I cannot comment on it; the same applies to his opinion on the neck wound.

Page 1: you're absolutely right, I want you to provide reasons for what you state as facts. Not semi-technical or pseudo-technical explanations, but just specific descriptions of what experimental tests or other work you base your points on, so I can tell what assumptions you are making. Your expertise alone will not convince me of anything.

You may discuss ballistics with me in Greek or Latin, if you wish. Were you planning to talk about monads too?

I too am getting exasperated. I don't know where you get the idea that I am interested in "protecting" Alvarez. I would be delighted to prove him wrong. Even if I wanted to curry favor with him - which I don't - the way to do that would be to come up with arguments that prove him wrong, not just to agree with him. I put in the Supplement the strongest arguments against his interpretation of the melon tests that I consider valid. You do not agree, of course, but I think that I put your argument about the fine fragments on stronger ground than you did in your letter; at least, that was my intention. Also, Alvarez has seen all my correspondence, and I will discuss your latest letters with him also. My belief that this work is not suitable for publication in a general journal remains as it was was stated in my memo of October 27.

Despite the tone and content of this letter, I would be pleased if you could prove your hypothesis. I don't claim that I or anyone else can prove it is wrong. But I cannot let your claims go unchallenged, especially when you use them to cast doubt on my competence and integrity as a scientist. Failure to respond would have seemed to some an admission of guilt. I'm quite willing to let the record - your letters and my writings - speak for itself. I note in advance that I will comment further only on any comments you have that are substantive and have not been fully covered before. If you want to make debater's points against me, you have carte blanche.

Sincerely,

Paul