THE BILLIARD-BALL PROBLEM

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THE *prima via,* or the argument for the existence of God from a study of motion, is cited by St. Thomas as the most manifest of all the proofs for the existence of a Supreme Being. Without doubt, this proof was the easiest to understand for the contemporaries of the Angelic Doctor, who commonly subscribed to the Aristotelian analysis of motion and thus were prepared to follow his argument leading to the existence of the first unmoved mover. But for the modern mind, there are difficulties in grasping Aristotelian concepts that were commonly accepted in St. Thomas' day. This is particularly true of Aristotle's analysis of motion, largely because of the preoccupation of physical scientists with motion, and because the solutions that have been accepted by them do not depend on Aristotelian notions and even are at open variance with the latter. Thus it is that a theologian attempting to teach St. Thomas' proofs for the existence of God to college students, and particularly to those well trained in the physical sciences, will run into difficulty at the very outset when he tries to explain the argument from motion. Because this proof is a rather fundamental one, the handling of difficulties connected with it may have a critical bearing on the students' attitude towards theology. Now it is possible for the teacher to say: "I do not know anything about modern science, *but* . . .", and then proceed to sidestep the student's difficulty with an argument from authority. But such a procedure is questionable on two counts: first, it rules out the primary consideration, viz., a demonstration of God's existence from *reason,* and secondly, it puts the lie to the thesis that theology is a wisdom as well as a science, and as such rules over all rational disciplines either in using their conclusions to lead men to God or in showing that they in no way jeopardize theological arguments. So it is rather important that an attempt be made to cope with the difficulties presented by the *prima via* when viewed in the light of modern physical science.

One of the more common difficulties connected with this proof, and incidentally one of the hardest to explain, is that raised by the "billiard-ball" problem, also referred to variously as the "projectile" problem, and the problem of the "thrown stone." This comes up in a defense of the principle invoked by St. Thomas: *omne quod movetur,*

ab alio movetur, which is basic to the *prima via;* it is explained as meaning that everything that is moved, is being constantly moved by another, at every instant of its motion, until it reaches a state of rest. St. Thomas proves this axiom directly from the Aristotelian definition of motion, and in his characteristically concise way does not digress over questions and problems that could have been answered satisfactorily by anyone acquainted with Aristotle's *Physics.* But the thoughtful student of today, in thinking about this principle, will usually be bothered with the question of what moves a billiard ball after it has left the cue, or with what moves a thrown stone after it has left the thrower's hand. Generally he will not know of Aristotle's solution to this problem, or if he does know of it, will not appreciate it. Thus his reasoning will go somewhat as follows: If the principle in question is true, then the billiard ball must continue to be moved by the player in its course over the billiard table. Now this seems contrary to experience, because it seems that the billiard player only moves the ball as long as he is in contact with it by means of the cue. Or to state the matter more technically, *actio in distans repugnat,* so it is impossible for the player to move the billiard ball unless he is somehow in contact with it, and the only contact he has with the ball seems to be his initial contact through the cue. But if this is so, then the billiard ball is not being moved by another, continually, at every instant of its motion. The consequence of this would be that there was an exception to the principle enunciated by St. Thomas as fundamental to the first proof for the existence of God, and thus the proof would be invalidated.

MORE PROBLEMS

Now if the student at this point makes recourse to the teachings of physical mechanics, he immediately gets involved in a more serious and fundamental difficulty. For the science of mechanics subscribes to the Newtonian analysis of motion, and Sir Isaac Newton was not overly concerned with such axioms as *omne quod movetur ab alio movetur.* In fact, one of the basic postulates of Newton's mechanics is that a body such as a billiard ball, after it has been placed in a state of motion, will continue in that state of motion until it is compelled by outside forces to come to a state of rest. Thus no consideration is given to an external agent continually acting on the ball to sustain it in motion; for all practical purposes, the ball is considered as moving itself indefinitely until it is forced to come to rest by a resisting body or medium. The complete physical analysis postulates some entity that has been imported to the ball at the point of contact with the cue.

This entity is known as momentum, referred to by Newton as the "quantity of motion," and equal to the product of the mass of the ball and its velocity. Whatever its mathematical value, however, the fundamental thing about momentum is that it sufficiently accounts for the motion of the ball without recourse to an agent constantly moving it. As a result, modern physicists can speculate about the motion of a body in a vacuum, and say that the body will move forever without its motion being diminished in any way whatsoever. And, in a sense, such an analysis does not overlook efficient causality entirely. A body at rest does not move unless momentum has been transferred to it by an impulse from another body. So initially, such bodies are moved by another. But as soon as the body has been placed in motion, influx from a moving body is regarded as no longer necessary. Thus it becomes impossible to sustain the Thomistic interpretation of the principle: *omne quod movetur ab alio movtur,* for while it may be admitted that everything that is moved, *has been* moved by another, it cannot be said that everything that is moved, is being constantly moved by another, at every instant of its motion, until it reaches a state of rest.

The problem comes into sharper focus when attention is shifted from the billiard ball to such things as heavenly bodies. For, if the analysis of modern physics is accepted, such bodies may have been placed in motion billions of years ago, but they are no longer being moved by an extrinsic mover. Thus, the view of St. Thomas that the heavenly bodies are constantly being moved by the angels, who are constantly being moved by God (in a different order), cannot be sustained. As a result, an argument that in any way involves the motion of heavenly bodies cannot be used to prove that, here and now, God exists. At best it can only be used to show that God *existed,* perhaps billions of years ago, and this is definitely not what St. Thomas is proving in the *Summa Theologiae.*

We might continue to speculate about heavenly bodies moving in a medium that approximates a vacuum, or about other abstract cases that have been conceived by theoretical physicists, but the problem of the billiard ball is sufficiently complicated for a start. In fact, it has certain advantages that permit gaining a foothold towards a solution of the problem of moving bodies. Man may not be privileged to learn all the details of the motion of heavenly bodies, but at least he is in a good position to investigate the details of the motion of a billiard ball.

AN INTELLIGENT APPROACH

But before launching into a philosophical analysis of this difficult problem in local motion, it will be well to stress the fact that

problems of this kind are not the simplest ones in natural philosophy. If the reader has any doubts on this score, all he need do is consult Aristotle's order of treatment in the eight books of the *Physics*. The Stagirite launches into the science of *ens mobile* with two fundamental books on the principles of nature and the definition of nature, respectively, before he even attempts a definition of motion in the third book. And in arriving at this definition, he does not touch any of the difficulties connected with local motion, but prefers to come to a definition largely through a discussion of qualitative changes of various kinds. The casual reader of Aristotle may wonder why he does not take up the seemingly simple case of an object moving locally from A to B rather early in the *Physics,* instead of referring repeatedly to changes from white to non-white, and musical to non-musical, and health to sickness, and hot to cold. Similarly, the problem of the thrown stone does not show up until late in the eighth, or last, book; in place of the thrower, we find frequent reference to the doctor, the housebuilder, the sculptor, the flute-player, the grammarian — all initiators of changes, but no local movers. And the reason for this is not hard to understand. Aristotle was undoubtedly convinced that local motion, founded as it is on quantity, which in turn follows on matter (the principle of unintelligibility), is basically unintelligible. So instead of studying the least intelligible objects—non-living bodies placed in local motion—to arrive at the principles of his science, he made his approach through a study of the more intelligible beings and the changes peculiar to them: the doctor who heals, the architect who builds, the grammarian who writes. This is the only intelligent approach, and one incidentally, that is completely overlooked by the modern physicist.

Thus if we are to attack the problem of the billiard ball, it is obvious that little progress will be made in its solution if we neglect the general principles and definition of motion that have been discovered through studies of bodies with more intelligibility than billiard balls. So it is that we first have to realize what motion of any kind is: it is, as St. Thomas says in the *prima via,* nothing more than the eduction of something from potency to act. Or to give Aristotle's original definition, motion is the act of being in potency, insofar as it is in potency. From this it follows that a thing cannot be moved unless it is in some way in potency to the term towards which it is moved. Moreover, it can only be moved to that term by something which is already in act with respect to the term. The simplest example that will make these points clear is that cited by St. Thomas, again in the *prima via,* viz., something which is in act with respect to being hot

—for instance, fire—makes wood, which is in potency to becoming hot, to be actually hot, and in this way the fire moves the wood insofar as it alters it. These general principles are easy to see in a qualitative application such as the burning of wood, which is a motion of a more intelligible kind than that of the billiard ball. The important thing to realize, however, is that the motion of the billiard ball will not be clearly understood until it too can be seen in terms of these principles.

Another point that is learned from a study of movers that are more intelligent than a billiard cue is this: no mover endowed with intelligence ever moves without doing it for some end, with some purpose in mind. The doctor who heals, the architect who builds, the musician who plays, the grammarian who writes—all do these things because of a goal, an end, which they wish to attain by the particular motion they initiate. Thus it is possible to infer a general principle from this study of intelligible movers, viz.: no mover ever moves without moving for an end. This principle, sometimes referred to as the principle of finality, is essential to a proper understanding of motion, and again, the motion of the billiard ball cannot be analyzed completely if it is overlooked. Needless to say, modern physics does overlook it, with rather disastrous results.

So we are led by our quest for knowledge about the billiard ball's motion to the point of asking ourselves some questions in terms of these general principles. What is the end, the *finis,* of the billiard ball? To what term is the billiard ball in potency? How is the mover of the billiard ball in act with respect to that term? Only when we have answered these to our satisfaction can we further unravel the mystery of the billiard ball's motion.

THE END OF THE BILLIARD BALL

It will be worthwhile to note at this point that the philosopher's attack here has a pronouncedly different emphasis from that found in the modern physicist's approach to the problem. To the physicist, the emphasis is on the word *ball;* what he wants to know is the mass of the ball, the impulse imparted to it, the geometrical details of the impact, etc. Given these, he no longer cares whether the problem concerns a billiard ball or any other kind of ball; his answer will be a perfectly general one. But the questions posed above do not neglect the essential note missed by the modern scientist. An answer to them will have to take into account the fact that there is a ball in the problem, but what is more important, it will also place a proper emphasis on the fact that it is a *billiard* ball.

If we are to concentrate on the billiards as well as the ball, then,

we will not overlook this essential point—namely, that the motion of the billiard ball does not start with the cue; it starts with the billiard player, a being endowed with intelligence, who in virtue of that intelligence possesses a certain power over the balls on the table before him. This may seem a small point, a picayune one to argue about, but it is only through an appreciation of it that we can come to the answer to our first question: what is the end of the billiard ball? For the end of the billiard ball is intimately tied up with the end of the billiard player. Given a particular situation, the billiard player has for his immediate end, his proximate purpose, to hit the cue ball with the cue in such a manner that it will hit the first object ball, then bounce off three cushions in succession to hit the second object ball, and finally end up with all three balls in such a position as to be able to make another carom. Obviously, we cannot talk about the motion of the cue ball and what it is trying to do, i.e., what its end is, if we completely neglect what the billiard player is trying to do. As soon as the ball has left the cue, it "knows" what its end is; in a very real sense it is being pushed along by the intelligence of the billiard player. It may have behind it the power of a world's champion billiard player, who knows just what he is trying to do and is endowed with the skill to communicate his intention to the cue ball. Or it may be propelled along by someone completely unskilled, who is endowed with weak intelligence *(qua* billiard player) and practically no art in carrying out his intention. But the fact remains that something of the billiard player goes along with the ball, guiding it, as best it can, to carry out a pre-conceived plan that will put the cue and the object balls in certain definite positions. And, as common observation tells us, the power behind the ball is much more important to the spectators than the billiard ball. Willie Hoppe and Johnny Jones may both play at the same table, with the same cue and the same balls, but the spectators will never credit or blame the equipment; it will always be what the players have communicated to the equipment that will receive plaudits or derogatory remarks.

Again, concentrating on this same point will supply us with the answers to the other questions we have raised. To what term is the cue ball in potency? It is in potency to being in a different position from where it was originally. Or, if the peculiar case arises where the player wishes to bring the ball back to its original position after the carom, it is in potency to the intermediate terms of hitting the first object ball, bouncing off the cushions, hitting the second object ball, and finally coming to rest in its original position. This answer is simple enough. But then what about the next question? How is the

mover of the billiard ball *in act* with respect to that term? The cue is not actually in the position to which it moves the ball. Neither is the billiard player. But the principle states that a thing can only be moved to a term to which it is in potency, by something which is already in act with respect to the term. How can the principle be verified in this case? What is the mover that is in act with respect to the new position of the cue ball?

Concentrating on the cue and the momentum it transfers to the ball will never give the answer to this question. Once again it is necessary to go back to the obvious but easily overlooked fact that the principal mover of the ball is not the cue, but a creature endowed with intelligence. The billiard player is the mover who is in act with respect to the new position. Granted he is not there locally, sitting on the spot to which he is to bring the cue ball. But he is there actually, and in a superior way to being there locally. He is in the new position *intentionally;* in his mind, before he makes the shot, he has an actual picture of the place to which he is sending the cue ball. What is more, he pre-conceives beforehand the positions at which he intends the ball will strike the cushions, the angles of rebound, etc. So the mover of the billiard ball is in act with respect to the latter's term; in fact, if he were not, there would never be any motion in the first place, for the very simple reason that the ball would not "know" where to go.

A PUZZLE FOR THOMISTS

Thus, arguing from Aristotelian principles, we find that the billiard player must have communicated some of his knowledge and power to the billiard ball, and that this is the proximate cause of the billiard ball's motion. As to the precise way in which this is done, however, there still remain some difficulties. These are somewhat complicated by the fact that it is not exactly clear what St. Thomas would say towards their solution. Actually, the Angelic Doctor seems to hold for one opinion in his commentary on Aristotle's *Physics,* and the opposite opinion in various other writings. Overlooking this inconsistency, some recent Thomists solve the problem of how the power is communicated from the player to the ball by saying that this is done by the *virtus* to which St. Thomas refers incidentally in his writings.[1] Thus they take this *virtus* as meaning a kind of motrix

[1] St. Thomas refers to a *virtus* as the proximate cause of local motion in the following three texts:

1. *De Pot. q. 3, a. 11, ad 5:* "An instrument is understood to be moved by the principal agent as long as it retains the *virtus* impressed by the principal agent; whence the arrow is moved by the archer as long as the impulsive force of the archer remains."

quality that is an *ens viale,* a transient being communicated to the ball, that continually generates motion in the ball until it is reduced to nothingness by collisions and opposing resistance. From this account it would seem that they have been influenced more by the teachings of empirical scientists on momentum than they have by Aristotle. This interpretation of *virtus,* of course, can be upheld; it is dangerous only to the extent that the *ens viale* becomes identified with a *momentum,* or other quality of the ball itself that makes it a self-mover. As long as the motrix quality is conceived as something of the billiard player that subsists in the ball, and continually moves it to the preconceived end, all of the principles of motion that are invoked in the *prima via* can still be upheld. But the nature of the motrix quality then remains somewhat of a mystery. Is it extrinsic to the ball, and yet a quality of the ball? Does it make the ball a self-mover, in any sense of the word? When we try to answer these questions, we see immediately that most of the difficulties of the billiard ball problem have been lumped in the concept of a motrix quality, and we are not much better off towards a solution than we were when we started.

It does seem better, therefore, to follow the teaching of Aristotle and St. Thomas in the classical *locus* on the problem of the thrown stone, and apply it to the case of the billiard ball. This is given in the eighth book of the *Physics,* chapter ten.[2] Here Aristotle circumvents the difficulty we have been discussing by saying, equivalently, that the original mover (the billiard player) gives the power of being a mover either to the air surrounding the ball, or to something else of the kind naturally adapted for imparting or undergoing motion, but not too the billiard ball itself. Modern physics rules out the air as a mover, but a recent writer[3] has proposed that this "something else" is the ether, i.e., the medium through which electromagnetic waves are believed to travel, that permeates all of physical space including the so-called "vacuum." If ether performs this function, then, according to Aristotle we must further say that the ether does not cease simultaneously to impart motion and to undergo motion; rather it ceases to be moved at the moment when its mover ceases to move it, but it

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2. *De Anima, a. 11, ad. 2:* "The *virtus* that is in the seed from the father, is a permanent *virtus* from within, not flowing in from outside, as is the *virtus* of the mover that is in projectiles."

3. *Summa Contra Gentiles, III, c. 24:* "For as the arrow follows the inclination to the target, to a determined end from the impulse of the archer, so natural bodies follow an inclination of natural ends from natural movers, from which they receive their forms and *virtutes* and motions."

[2] Cf. also St. Thomas' Commentary, Lesson 22, No. 3.

[3] P. Hoenen, S.J.

still remains a mover. Further, the ether is a continuous medium, and part of it acts against each consecutive part. The motion therefore begins to cease when the motive force produced in one part of the consecutive series is at each stage less than that possessed by the preceding part. It finally ceases altogether when one part of the ether no longer causes the next part to be a mover, but only causes it to be moved. The motion of the last two members—one mover and the other moved—must cease simultaneously, and with this the whole motion ceases and the billiard ball come to rest.

By way of a corroboration of this view from the teaching of modern theoretical physicists, Fr. Hoenen cites the DeBroglie waves in the ether that are thought, in accordance with quantum mechanical considerations, to accompany all moving bodies, as evidence for the interaction of the ether with the moving body. While this may be somewhat far-fetched, at least it shows that there need be no opposition on this point between the respective findings of philosophical and empiriological physics.

A REALISTIC ANSWER

This then seems to be the best answer that can be given at present to the problem of the billiard ball. The ball is moved continually by the billiard player, from the moment it leaves the cue until it comes to rest in its new position on the billiard table. By reason of his intelligence, the player holds a real power over the ball. His impulse through the cue places a certain *virtus,* resulting from that power, in the medium surrounding the ball, most probably in the ether. This propels the ball along, moving it at each instant of its motion, directing it, acting on it in place of the player, until it brings it to rest at the preconceived position. Thus the ball is acted upon by the player at each instant of its motion, and the principle invoked by St. Thomas in the *prima via: omne quod movetur ab alio movetur,* is verified even in the local motion of the billiard ball.

Moreover, the arguments raised from the physicist's concept of momentum cannot invalidate this principle. No matter how big we make the billiard table, nor how smooth we make it, nor how strong we make the billiard player, the ball will never continue to move in a straight line to infinity. Why? Well, first of all, for the very obvious reason that we can't play billiards that way. And secondly, if we build a very long table, and try to hit the ball so hard that it will go on indefinitely, it will never move at all unless the man who hits it at least preconceives a term for the ball at the end of the table. The same thing applies if the ball is shot from a gun, instead of being hit with

a cue. As long as we remain in the real order, the analysis based on Aristotelian-Thomistic principles will have to hold. Of course, if we are to go to the logical order where we can conceive of an infinitely long surface that is completely frictionless, in a vacuum, etc., and thus make momentum an artificial mental construct, possibly we can conceive of the ball "moving itself to infinity." But then the physicist's concept of momentum is nothing more than a dialectical concept; as such, it can never jeopardize an argument taken from the real order, as is St. Thomas' *prima via.*

Thus we see that the modern physicist's difficulties take their origin from an incomplete analysis of the realities involved in the billiard ball's motion. When all the realities involved are seen in their entirety, the billiard ball and its motion need not deter men from grasping St. Thomas' first proof for the existence of God. Rather, because of the peculiar rôle of the guiding intelligence of the player in the game of billiards, a profound study of the billiard ball in its caroms should make it easier for the natural philosopher to grasp the fact of God's existence.

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