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Abstract: One of the core tenets of reductionism is the ideal of unity, of a unified, comprehensive understanding of reality. And although it is in principle not necessary to do so by choosing physics as one's fundament, it is a natural choice: everything we can study empirically is made of, or otherwise involves, physical stuff, physical happenings, or physical forces. From this physicalist-reductionist perspective, claiming that one or the other phenomenon cannot be reduced (in some informative sense) to the physical level amounts to giving up on the ideal of unity: it leaves us with unsatisfactory forms of dualism or pluralism. I will argue that the reductionist is right: unity is ultimately crucial. The error of the reductionist lies not in her commitment to unity, but rather in her assumption that this requires singling out one level – paradigmatically the physical – as the only metaphysically fundamental one. And so we can say that the pluralist, too, is right: the variety of natural phenomena, reflected in a variety of scientific disciplines, is best understood as a metaphysically genuine plurality. The error of the pluralist lies not in her recognition of this plurality, but rather in her assumption that this requires rejecting the ideal of unity. I conclude by sketching a synthesis of unity and pluralism: unity without reductionism.

§1: opening. First of all, I would like to thank the *Kurt Gödel Freundeskreis* as well as the *interdisziplinäres Zentrum für Wissenschafts- und Technikforschung der Universität Wuppertal* for organizing this *Festkolloquium*, and for providing me with this opportunity to share some of my thoughts on the limits of reductionism. It truly is a great honor.

§2: introduction. The reason why I am now giving this presentation is, as you know, that I submitted an essay on the limits of reductionism for the Kurt Gödel Award essay contest in 2019. Those of you who have taken a look at that essay will know that I am no friend of reductionism. However, I do believe that it is worthwhile to explore what it is, exactly, that makes reductionist views so popular. For I believe that any view that is worth taking seriously contains some grain of truth or insight.

In fact, I think that there is a danger in simply rejecting every view with which one at first sight disagrees without pause. And that danger is as follows. By jumping to an all-out rejection of such a view, we will find ourselves endorsing the negation of the rejected view. But in that case, we are still letting the rejected view determine what our own view looks like. Instead of saying 'Yes' to that view, we are saying 'No' to that view. That is what happens, for instance, when we flip over from reductionism to anti-reductionism. But then it is only to be expected that the resulting 'anti'-view is eventually found to be just as unsatisfactory: the anti-view cannot honor whatever it was that made the rejected view look justified and attractive. In short: we end up with an unsatisfactory duality of views, and no real progress is made.

Now, today I hope to contrast this dynamic of view and anti-view that makes no progress with a different approach. On this different approach, our first move is *not* to reject the unsatisfactory view, but rather to inquire into its grain of truth. Then, we may discover how the view *itself* fails to live up to that grain of truth. The result of this procedure can be called a *progression*: the

given view itself gives rise to something new, the next step grows naturally out of it. And this, I submit, holds the promise of real progress in our understanding.

As I said, my aim today is to illustrate this for the case of reductionism. At the end of this presentation, I will allow myself a few further remarks on this procedure in philosophy, this method of growing a new view out of a given one through some progression. But let us now dive into the topic of reductionism.

§3: reductionism. The word 'reductionism' comes from the Latin verb *reducere*, literally meaning "to bring back" or "to restore". And a reductionist indeed thinks that all there is to the world, the whole colorful diversity of phenomena, can be 'brought back' or 'restored' to – well, to *something*. What this 'something' is can be very different among different reductionist views. In any case, it should be something that the reductionist takes to be extremely well-understood, uncontroversial, unproblematic, or basic. Let us call this 'something' to which the reductionist wants to bring everything back the *reductive base*. Nowadays, most reductionists will embrace as their reductive base the realm of physics. And there is surely something to be said for this choice: it looks like all we are ever dealing with is made of, or otherwise involves, physical stuff, matter. That is, indeed, a very basic observation.

But that is not the sole reason for preferring the realm of the physical as one's reductive base. For, by parity of reasoning, we could also say that space, or time, or perception, should be the reductive base. All we are ever dealing with is, after all, something located in space, present in time, and disclosed to us through our senses. And, of course, there have been thinkers defending corresponding versions of reductionism. The most fascinating example here is, undoubtedly, George Berkeley, with his slogan "esse est percipi", to be is to be perceived.

Anyway, the physical enjoys particular popularity nowadays. But that would not be the case if the physical realm itself were utterly incomprehensible to us. And so, in addition to the pervasiveness of the physical, it is, thus, precisely our advanced understanding of the physical as such which makes it attractive as a reductive base. The important concept here is that of trust, or certainty: the physicalist reductionist trusts our understanding of the physical, and finds that it enjoys a level of certainty which is absent from our understanding of the living world, the social world, or other realms.

As an aside, let me remark that there is an interesting connection here with mathematics. As Immanuel Kant famously said, "in any special doctrine of Nature there is only as much genuine science as there is mathematics."[1] Apart from the specific reasons Kant had for making this assertion, there surely is something to be said for the claim that the certainty and trust physics as a science enjoys really derives from the certainty and trust we naturally put into mathematics. Nothing is more certain than mathematical proof, after all. It is not surprising, then, that Kurt Gödel hoped to find, in his incompleteness proofs, a trustworthy basis for his strong antireductionist beliefs.

[1] Kant: Metaphysical Foundations of Natural Science (1786). From Jonathan Bennett's earlymoderntexts website: https://www.earlymoderntexts.com/assets/pdfs/kant1786.pdf, p. 3.

Be that as it may – shouldn't we insist, in the face of such a physicalist reductionism, that it is simply in error, that it is wrong? I myself have argued in different occasions, including my contribution for the Kurt Gödel Prize, that the realm of the living, for instance, cannot be understood in physical terms. And similar arguments can be made, and have been made, for consciousness, thought, value, meaning, morality, or whatever your favorite anti-physicalist example may be. But before we reject physicalist reductionism in this manner, let us pause to make sure that we don't throw out the baby with the bathwater. Let us take a look at the grain of truth in reductionism.

§4: the grain of truth in reductionism. Why does the physicalist reductionist want to bring everything back to physics? Suppose that there is some phenomenon, or some realm of phenomena, that resists such reduction . Then, by the physicalist's lights, this realm ends up hanging 'in the air', so to speak. There is the orderly realm of the physical, and then there is this annoying extra bit of reality that, inexplicably, is present amidst the physical realm, but obeys laws of its own – or, worse still, obeys no laws at all. This is the line of thought that motivates physicalists to argue against the very possibility of such a situation. Perhaps the most pervasive such argument is one that is based on the so-called "causal closure of the physical": roughly put, the upshot of this argument is that anything which interacts with the physical must itself be physical.

Apart from this causal closure argument, this is something that we should appreciate as an honorable motive within reductionism: no aspect of reality should be left 'hanging in the air' as an inexplicable, miraculous phenomenon. But when we respond to reductionism by simply rejecting it, when we become *anti*-reductionists in this way, we end up with precisely that: everything we claim *not* to be reducible to physics will appear as such an inexplicable, miraculous 'extra' within the all-encompassing physical universe. We get our pluralism, alright, but we lose the unity of reality.

The grain of truth in reductionism, then, is its uncompromising adherence to *unity*. The ideal thus is, to use a popular phrase, one big 'theory of everything', which captures the *whole* of reality, and thereby ensures that everything hangs together, without any inexplicable danglers.

Let us reflect on this ideal of unity a little further.

§5: unity. As Aristotle remarks in the opening sentence of his *Metaphysics*, all men by nature desire to know, to understand. We find ourselves surrounded by an enormous and enormously rich array of phenomena. An endless manifold of separate goings-on. And at first sight, all these goings-on are simply *there*, we register them somehow, inchoately, but we do not see how the manifold phenomena hang together. There is, initially, barely any unity to this manifold.

But this image, of an endless, disintegrated array of separate phenomena, changes once we start inquiring into some phenomenon. The better we get to know that phenomenon, in its relations to surrounding phenomena, to its causes and effects, etc., the more integration we bring into the picture . What first appeared as an isolated entity, or happening, now appears as the natural

result of preceding happenings, and as naturally giving rise to subsequent happenings. Where that phenomenon was, at first sight, one big question mark, we now know *what* it is, *why* it came about, and *how* it influenced subsequent events. Nature starts to appear as an organized, unified whole, despite all the diversity that it displays.

This we can appreciate as the motivation, the drive, of science in general: to bring back all those loose and separate phenomena to their proper place within the larger scheme of things. Or: to restore those phenomena to their place within the organized whole of nature. – Notice that I've just used the verbs "to bring back" and "to restore": these correspond to the Latin *reducere*, as we saw: the root of our term *reductionism*. And indeed, the reductionist is very faithful to this motivation or drive. The reductionist will not rest content until all has been brought back, or restored to its proper place within the larger scheme of things. And our reductionist thinks that physics *is* this larger scheme of things.

§6: reductionism defeats itself. The reductionist wants to bring back all phenomena to the realm of physics. Thereby, they are restored to their proper place within the all-encompassing, mathematically articulable, natural order that physics aims to discover. But now we must ask: is this restoring really successful? Does it live up to its own demands?

Generally speaking, the way in which phenomena are restored, in the physical sciences, is by understanding them to be lawfully connected to preceding happenings. For example: we witness the collision of two billiard balls, and we understand why that collision came about by tracing it back to the impact of a cue on one of the balls. In this way, the collision acquires its proper place within the unfolding of events over time.

We can also put this as follows. At the outset, the collision, the phenomenon in question, can be thought of as containing a question mark: here I am, but – why am I here? The phenomenon in isolation is thus *incomplete*. It points to something outside of itself. And the incompleteness is resolved, the question it poses is answered, by linking the phenomenon to some other phenomenon . Ideally, this link is provided by a mathematically framed law of physics.

However, we now immediately face a problem. The phenomenon in isolation is *incomplete*, we saw, but we can only resolve that incompleteness by relating it to other phenomena, which are *themselves* just as incomplete. It is like solving an infinite jigsaw puzzle without edges .

In this way, I submit, we can come to see why the physical realm, despite its universality, does not really answer to the quest for unity that the reductionist rightly embraces. It operates with a method of completion which forever remains incomplete. Its aim of restoring the phenomena to their proper place puts up a standard which the form of understanding things found in physics doesn't live up to.

Now, this is, of course, quite a sweeping diagnosis, which will spawn many questions. Where does this standard of completion really come from, and why is the physicalist reductionist bound to it? I believe *these* questions can be answered by reflecting on the question what it is to be confronted with phenomena in the first place. But I will leave that to another occasion.

Today, it is my aim to bring out how we can, on the basis of this diagnosis, grow the grain of truth contained in reductionism into an anti-reductive view.

§7: the growth of life. Now let us take stock. The reductionist demands that every phenomenon be given its proper place within the all-encompassing order of things, and believes that embedding it in the order of *physical* goings-on is the only acceptable way of doing so. She regards the phenomenon to be incomplete in itself, and believes that relating it to other phenomena by suitable, mathematically perspicuous laws resolves that incompleteness. But in effect, this puts the phenomenon into a series of phenomena, each of which is in itself incomplete in the very same way.

Now, if we try to think a *completed* series of such phenomena, we think of the series as coming to an end. What terminates the series, X here, must then be something which (a) can be seen to give rise to the subsequent phenomena, but (b) without itself requiring that sort of grounding.

And that is contradictory. Thinking (a), we find ourselves with the idea of something that grounds phenomena, and so it must itself also be some phenomenon. But, thinking (b), we think of something which is no phenomenon at all, and so cannot explain a series of phenomena. In short: we find ourselves with an impossible requirement. A *deus ex machina*.

As an aside: it would be interesting to look into the concept of the Big Bang from this perspective. It is sometimes jokingly said to come down to this: "First there was nothing, and then *it* exploded". The joke precisely brings out, I think, the tension in the very idea of a physical phenomenon that gives rise to subsequent phenomena, but without itself being grounded in preceding phenomena.

But let us look closer at the contradiction that we found. It is familiar to those who know Immanuel Kant's work: it is, in essence, one of his famous Antinomies, which he presents in the *Critique of Pure Reason*. But, as Hegel equally famously observed, one can read these Antinomies in a way that yields something new. When we think this antinomy, we think the limits of physical explanation. But, as always, a thought of some limit doesn't itself conform to that limit. When I think of the borders, the boundaries, the limits of the Netherlands, I am *thereby* thinking of what lies beyond those limits. My thought of a limit distinguishes what lies within that limit from what lies beyond that limit.

And that is in fact what we find here. When we stop staring at the limits from the side of what is limited by them – physical explanation – we can start looking at that which lies beyond those limits. In this way, we progress from the concepts involved in purely physical explanation to something entirely new.

Here is an attempt to bring this out. We found ourselves thinking of a phenomenon that doesn't rely on some externally given, further phenomenon for its completion. But this doesn't have to mean that it is groundless. It means just that its ground is not *external* to it. The phenomena in question can also be *internally* related – and this internal relation is the new, non-physical explanatory concept. Phenomena of this new kind are what they are, *as* phenomena, only

through being so related. Phenomena of this new kind aren't isolated in the way physical phenomena are.

This sounds very abstract, but is really concrete. It is just what we find in the realm of the living, in biology . Living beings develop according to a life cycle, which simply *is* a cycle of phenomena related in the envisaged internal way. The internal unity of these phenomena then takes the place of the external ground which physical phenomena invariably require. The ground of the series lies in the teleological unity of its members. Now we are thinking outside of the limits of the physical.

This picture of life as the realm of such teleological causation is controversial, to put it mildly. However, we need not enter into a full discussion and defense of the logical form of life and all the issues this raises here. What matters for present purposes is *how we arrive* at this understanding of life. So let us do a little recap.

§8: recap and reflection. We started out with the idea of physical phenomena. These are such as to be related to further physical phenomena through mathematically expressible laws of physics. Every such phenomenon, considered in isolation, is incomplete. Every such phenomenon is a question after its own ground. But, as we saw, this leads to problems. The problems arise when we inquire into the possibility of a *completion* in this domain. This seems to take us to puzzling questions regarding the beginning and the end of time, but it is important to stress that *that* is not the real issue here. The real issue is not primarily how we should think about, for instance, the Big Bang, but rather what the very nature of physical phenomena is. And we must conclude that it is contradictory. It absolutely demands completion of a form which by its own lights is impossible. That is the limit of the physical.

When we think through this limit which is inherent in the very idea of a physical phenomenon, we find out that we *thereby* arrive at the idea of phenomena *not* bound to that limit. We think of the teleological way phenomena belong together as the gradual manifestation of a unified life form.

Now, whatever you may think of these lines of thought, at least you will agree that we have now arrived at a truly non-reductive view. We have concluded that we cannot rest content with the external order among phenomena that physical laws and explanations provide. We need to acknowledge, *in addition*, phenomena which are internally ordered according to their governing principle of life.

However, I hope that I have succeeded in at least highlighting the possibility of seeing things differently here. For I haven't really argued that we need to *add* something to the physical realm. I have tried to sketch how we can come to see that it is the very idea of the physical realm *itself* that gives rise to the 'addition'. And then it is not really an *addition* to the physical. It was there all along!

This may be confusing. I claim that the idea of life can be lifted directly out of the idea of the physical. I do not thereby claim to have any knowledge of how, where, and why life started within the physical universe.

But we might also turn this around. Instead of looking at the marvel of self-organization in the realm of life, I must say that I find it increasingly baffling that there is this vast physical realm, this entire physical universe, from which this self-organization is *lacking*. The notion that inanimate matter is no problem, while life poses special explanatory demands, is so deeply ingrained in our contemporary, modern scientific thinking, that it may be hard to come to appreciate this standpoint. At any rate, maybe the largest riddle in our universe is not how it gave rise to life, but rather why it appears to be largely dead.

§9: where to go from here? The step from physics to biology, from dead matter to living beings, is just one step. We could spend hours discussing the subsequent steps to conscious life and then to our own, rational form of life. These steps expand the non-reductionism: consciousness cannot be reduced to life, and thought cannot be reduced to consciousness. But, again, I also believe that these steps do *not* add something new, but rather develop what is present in the very idea of life from the very beginning.

And so my claim is that, indeed, when physicalist reductionism thinks itself through to the very end, it will transform itself into an non-reductive view. But it will not do so by letting go of the original reductionist motivation of unity. Rather, it will do so by finding out how that ideal of unity *from itself* initiates a progression which takes us from the physical to the animate to the conscious to thought. Accordingly, the activity of *reducing*, of 'bringing back' or 'restoring', will take on new shapes as we ascend this ladder of nature. In this way, then, the grain of truth contained in reductionism naturally grows into something that is no longer characterizable *as* reductionism.

This is in no way an original insight of mine. It is just to rediscover what, for instance, Hegel attempted to do, in his own, very Hegelian style, in his *Science of Logic*. And it is what Aristotle attempted to do, at least in part, in his *De Anima*, which treats of 'the soul' in a progression from plants to animals to thinkers. I wouldn't mind if my contribution today was heard as an encouragement to revisit both of these works and their authors. But I think that, in the end, the only truly fruitful way of engaging with them is by rediscovering what animates their philosophical thought within our own thought. And I believe that what we need to do so is precisely what I tried to bring out today: we must recognize that every view worth considering contains some grain of truth, which, when properly appreciated, will outgrow all limitations besetting that view. Then we can find trust and certainty not just in the perfect clarity of mathematics, but in the power of reason itself. And then we can say, with Hegel, that "reason is the certainty of being all reality".

I thank you for your attention.