HOW DID 'JUDGEMENT' COME TO BE A TERM OF LOGIC?

PER MARTIN-LÖF

One year ago—it was exactly the 14th of October—I began a series of seminar lectures which made up a kind of synthesis of the philosophical work that I have been doing during the five last years or so. Hopefully, this was to the benefit of some, at least, in the audience. Today I would like to do the dual thing, namely to show in what way I have benefitted from being here in Paris.

There is a certain problem, namely the problem that you all have seen, which makes up the title of my talk, which has occupied me for some time. About two years ago I reached a point where I realized, No, unfortunately I cannot get to the bottom of this, because I would need the help of experts of a kind that we simply do not have in Sweden. For some reason I knew on general grounds that such people are present in France, in particular here in Paris, so I thought when I got this chair that I now will really try to use the opportunity of finally getting to the bottom with this problem, namely the problem of where we have the logical term judgment from.

The question

How did judgement come to be a term of logic?

has at least two presuppositions. The first is of course that the primary sense of judgment is the juridical one, which is older than the logical sense, and that the logical sense is somehow connected with the juridical sense, although in not so exact a fashion perhaps. This presupposition I take to be unproblematic. The other presupposition is of course that judgement is a term of logic. There I could well imagine protests from those who have been educated in the way many of us have been educated during the era in the history of logic that has been dominated by the metamathematical paradigm from the 1920s and onwards. Where did we find the term judgement at all in our textbooks? Nowhere, I would say. To the extent that the term is at all a term of logic presently, it is because I started to use the term in connection with intuitionistic type theory in the late 1970s. Since then, it has become a standard term in computer science logic, used not only in connection

with my system of type theory, but in connection with other systems as well that are developed on this level of judgements, rather than on the propositional level.

The reason I introduced the term was that I needed some term that made a good contrast with proposition. What was there available? Well, there was Frege, who had a clear distinction between Urteil and Satz, which is to say, judgement and proposition, and there was Russell's rendering of it in English, already in the *Principles of Mathematics* from 1903. Russell did not use judgement himself. He used the term judgement in his discussion of Frege, but the term itself he skipped in favour of assertion—so, either assertion or judgement, and they both make a good contrast to proposition. I must therefore have had a choice: should I take assertion or judgement? I clearly took judgement, and I think it is mostly a question of your logical or philosophical affinities.

The term assertion is now the accepted term in Anglo-Saxon philosophy, especially analytically oriented Anglo-Saxon philosophy. Russell certainly replaced judgement by assertion in order to make a break with the preceding British idealism, in the first place, but also German idealism, and with the German tradition in general. He chose this excellent term assertion, and it came to be the winning term in this part of philosophy.

On the other hand, one may have the wish not to break with tradition: one may have the wish to show that there is continuity, and during the whole era of modern philosophy, from Descartes up to Frege and Husserl, say, the term used for this was judgement. When I say 'for this' I mean that when we reason, we reason stepwise, and in each step we have already established certain things, and then we make an inference step and reach a conclusion which thereby becomes established, through that step. What are these things called that we step from and to when we make our inferences? Well, the term used during this era in philosophy was judgement. We know Descartes used judgement in the *Meditations*, for instance, particularly in the third meditation. He did not write any logic, but it is fair, I think, to consider *La logique de Port-Royal* as the Cartesian logic, and the *Port-Royal* logic is divided into four parts: des idées, du jugement, du raisonnement, de la méthode. There we have, in the second place, du jugement, and there remains the interesting question if this order is the right one in our eyes, but that is not the topic for this lecture. This was the *Port-Royal* logic, and if you look at Kant's logic, for instance, it has the same structure: von den Begriffen, von den Urteilen, von den Schlüssen—judgement again in the second place. Frege I have already mentioned.

Judgement was simply the accepted term during a period of around 300 years. But many terms in the beginning of modern philosophy, in Descartes in particular, were not entirely new, but had a Scholastic origin. That is the case also with the term judgement. If you go back from Descartes what is most easily accessible at first is Ockham's logic, because it is well edited. It is easy to check that the term judgement is not used at all in Ockham's logic. On the other hand, in some other writings of his, he has a beautifully clear distinction between the *actus apprehensivus* and the *actus judicativus*, that is the act in which you apprehend

the proposition versus the act in which you judge it to be true or, possibly, false. There we have at least the *actus judicativus*, and that is already more than 300 years earlier than Descartes.

If you proceed backwards, another philosopher that it is easy to check because of the availability of good dictionaries is Thomas Aquinas. It is indeed easy to see that he used the term judgement, and moreover, he contrasted the *judicium verum seu rectum* with the *judicium falsum seu erroneum*. If propositions are the truthbearers, that is, propositions are the things that are true or false, Thomas clearly felt the need of using some other term in connection with judgement: judgements are either right—or, correct is maybe better in English—either correct or erroneous, as opposed to propositions' being true or false. This terminology was taken up by both Bolzano and Brentano in the 1800s. There is a book by Brentano, for instance, *Die Lehre vom richtigen Urteil*, posthumously edited, where you have this notion of richtiges Urteil. I take it for granted that their source was Thomas, because they were, after all, both of them educated Catholic priests and had presumably been through this in their priest education.

Now we are back in the middle of the 1200s, and how to get further? One step further for me happened in the following way, that the last five years of my teaching in philosophy I simply taught the *Organon* in order to read the *Organon* properly myself, and in five years we reached up to and including *Analytica Posteriora*. For each of the parts of the *Organon* I naturally used the *Aristoteles Latinus*, which is an excellent help, and where you can see how the various logical terms were transmitted, or translated, into Latin. In particular, I did so in the case of the *Posterior Analytics*, and there the situation is the following.

Unlike all the other parts of the *Organon*, which were translated by Boethius, and we have access to these translations, Boethius' translation of the *Analytica Posteriora* was lost, though it is known indirectly that he translated it. It therefore had to be retranslated in the Renaissance of the 12th century. There were translations by Jacobus Veneticus and by a certain Ioannes—whom we know nothing about except his name, essentially—both in the 1100s and in Italy. William of Moerbeke worked over the Jacobus translation in the middle of the 1200s, so 100 years later, but that is a rather minor change, making it more up to date.

In addition to these volumes, *Aristoteles Latinus* contains a fourth translation which looks very strange. This fourth translation is by Gerardus Cremonensis, the most distinguished translator of the Arabic, that is, of the Toledo school. The reason why it looks strange immediately is that it was made from the Arabic into Latin, and not from the Greek original. Nevertheless, Lorenzo Minio-Paluello, who edited this volume, included it among the Latin translations and, moreover, made a considerable amount of work on it, collecting an index, among other things. If you look at this index [shown on a transparency], you see that here you have judico and judicium, and moreover, Minio-Paluello has marked them with a star, which is just to indicate that he thought that these were especially worth noticing. This immediately caught my attention: what is this? If you count the number of occurrences, you will see that there are 13 occurrences of judicium and 19 occurrences

of judico in this Latin translation. I knew perfectly well, however, that there is no κρίσις, which is the Greek corresponding to judicium—not a single occurrence in the whole *Organon*. And judico the same: κρίνω in the *Organon*? You find some occurrences in *De Anima*, but not in the *Organon*.

We therefore have some influx here, quite clearly, of judicium and judico from an original which we know to be Arabic, and that meant that I was unable to proceed further with this, for the obvious reason. What I could do was to check these places, $13 + 19 = 32$ places. I could check them against the Greek original, and that already gives some information, which I have collected here.[1]

> 72a8
>
> πρότασις δ' ἐστὶν ἀπωφάνσεως τὸ ἕτερον μόριον, ἓν καθ' ἑνός
>
> Et propositio est una duarum partium contradictionis, scilicet judicium unius super aliud
>
> [A proposition is one part of a contradictory pair, one thing said of one.]

> 72a11
>
> ἀπόφανσις δὲ ἀντιφάσεως ὁποτερονοῦν μόριον
>
> Judicium vero est quelibet pars contradictionis
>
> [A statement is one part of a contradictory pair.]

> 72a19
>
> θέσεως δ' ἡ μὲν ὁποτερονοῦν τῶν μορίων τῆς ἀποφάνσεως [ἀντιφάσεως]^n λαμβάνουσα, ...
>
> Et positio dividitur: nam de ea est que accipitur taliter secundum quod ipsa est pars contradictionis quecumque fuerit, ...
>
> [A posit which assumes either of the parts of a contradictory pair...]

If one just asks outright, Judgement, which term does Aristotle use for this concept? If one has read the *Organon* it is clear that what ought to correspond to it is ἀπόφανσις as it is introduced in the *De Interpretatione*, where you have the most occurrences, and then you have in addition three occurrences in *Analytica Posteriora*. We can therefore at least look up these three occurrences in *Analytica Posteriora* and see how they correspond to what we have in the Gerardus Cremonensis translation. The outcome is the following.

In two of these places we indeed find judicium, the two first passages here. In the second place, that is only one place, but sufficient to show that, indeed, judicium corresponds to ἀπόφανσις. In the first place it is tricky because—well, you immediately see that you have judicium there, but it does not correspond to the ἀπόφανσις in the Greek. Rather, it is the ἓν καθ' ἑνός in Greek—one thing about one thing, which is to say the predicate about the subject—which has been expanded in the translation into *scilicet judicium unius super aliud*. So judicium here is an addition which has nothing corresponding to it in the Greek original.

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[1] The English translations, added in this transcription, are by Jonathan Barnes, from the *Clarendon Aristotle Series* edition of the *Posterior Analytics*.

Nevertheless, this 72a8–9 is a place where you have judicium in the translation and you have ἀπόφανσις in the original.

In the third place, on the other hand, there is simply no judicium at all, although you have ἀποφάνσεως in the Greek. That is because of the multiplicity of manuscripts. In most of the Western manuscripts, on which our text is based, you have ἀπόφανσεως here. But there is one manuscript—which is called *n* and is as early as any of these manuscripts, from the 9th century, and is in the *Biblioteca Ambrosiana* in Milan—which in many, many places gives a better reading than the standard Western manuscripts. Presumably, it is from a different manuscript tradition, I guess more Eastern. In this particular place, it has ἀντιφάσεως instead of ἀποφάνσεως, which is to say, contradiction instead of judicium, and it gives better sense in this passage, so there is nothing mysterious about this, it is simply that this Arabic text that Gerardus translated clearly was based on a Greek original which followed *n*.

At least we have now established that judicium indeed translates ἀπόφανσις. A mystery remains, however, even if we are generous and count these as two places, and not only one: there remain 11 occurrences of judicium in the translation without any base at all in the Greek, and then for the verb judico all the 19 places lack the corresponding Greek verb. If you look at all those places, you will see that what Aristotle writes is just say, I mean one of the three Greek possibilities that you have for say: λέγω, εἶπον, φημί. It is this which has been translated by Gerardus Cremonensis as to judge, so it is quite a significant step that has been taken there.

How to proceed further with this? Well, clearly someone who can read the Arabic is necessary. There are such people here, and I have been helped by Ahmed Hasnaoui with this difficult point.

We have to find the Arabic text, to begin with. It turns out, here Minio-Paluello did great work. There is the standard Arabic version of the *Analytica Posteriora*, which forms part of the Baghdad *Organon*, which you have here in Paris—for a long time it was the only copy, and maybe this is one of the reasons why there is such strength here in this area. This is the standard translation, and Minio-Paluello naturally began by comparing Gerardus Cremonensis' translation with this standard Arabic version and found that, No, they do not agree at all. His conclusion was therefore that there must have been a later translation, unknown to us, which he called the anonymous translation. What is more miraculous is that he was able to establish that the same anonymous Arabic translation served as a basis for Averroës' *Commentarius Magnus* on the *Analytica Posteriora*. Although the Arabic version of this *Commentarius Magnus* was also lost and Minio-Paluello only had access to the Hebrew version of it, that was enough for him to establish that, Yes, indeed, Averroës must have used this same translation as Gerardus Cremonensis. Then, maybe 30 years ago or so, the Arabic version of Averroës' *Commentarius Magnus* was eventually found, almost all of the first book, which means that—since the commentary is written in the usual commentary style, with the lemmata just verbatim taken from Aristotle and then comments after that—in the form of these lemmata, we now do have the Arabic text.

So we have two translations to compare with: the standard translation, which was made by Abū Bišr in the late 800s, early 900s, and this anonymous translation, which we now know that Gerardus translated. Comparing Gerardus' translation with these two Arabic versions and with Aristotle gives, fortunately, a very clear answer.

Arist.	Abū Bišr	Anon.	Gerardus
ἀπόφανσις	ḥukm	ḥukm	judicium
—"—	qawl, saying	—"—	—"—
λέγω (εἶπον), φημί	qāla, say	ḥakama, judge	judico

First of all we have this one, or if we are generous, these two occurrences, of ἀπόφανσις in Aristotle corresponding to Gerardus' judicium. In this case the answer is simple: both translations have the arabic ḥukm, which is judgement—I mean, there is no problem in translating ḥukm, because everybody agrees that that is judgement. Moreover, as I said in the beginning, ἀπόφανσις occurs primarily in the *De Interpretatione*, and there again we can see that it was translated by ḥukm in the Arabic translations.

Then there is the question, What about these 11 occurrences of judicium which have no counterpart in Aristotle? There is a discrepancy there, and where was it introduced? Was it by this anonymous translator, or was it by Abū Bišr? If one looks at the texts, one sees that Abū Bišr has there normally something with quawl—which means saying, or sentence, if you want, but saying, most literally—although there is nothing in Aristotle, and this was changed by the anonymous translator into ḥukm. So, saying was changed into judgement. We thus have discrepancies in both steps here. Firstly, Abū Bišr introduced something which was not in Aristotle, and that, it seems clear to me, is just because of Aristotle's very compressed style: you feel the need to insert some words somewhere, and that was his choice. Secondly, the interesting discrepancy is in the passage from saying to judgement made in the anonymous translation.

Then we have the judico, which, as I have already said, corresponds to one of the Greek words for say. Abū Bišr quite correctly translated that as say, I mean the Arabic for say, and it is again this anonymous translation which introduces the discrepancy, namely he simply changes this to judge.

So

$$\text{saying} \longrightarrow \text{judgement}$$

$$\text{say} \longrightarrow \text{judge}$$

summarizes the result of this investigation.

One can try to interpret this in an innocent a way as possible or in an interesting a way as possible. The innocent way would be to say that, apparently, this anonymous translator felt the need of making clear that say does not mean just utter the words: you should also mean what you say, and when you utter a declarative sentence and you mean it, you make a judgement. It should not just be the uttering of a sentence, but it should be a judgement. That would be an innocent way of interpreting this.

I tend to think that it is more interesting than this, and that it reflects some kind of development. Of course, there is no chance, again, for me to settle this question. I am just proposing two alternatives here, but to settle it, one would have to read these two translations in extenso and get a general impression of what change it is that took place between them. The more interesting way of explaining this would be that, there is a very significant fact in the development, not only of Arabic logic, but of logic as a whole, that took place around 900. When Aristotle's logic reached Baghdad at that time, in the late 800s, there was already a very strong indigenous grammatical tradition. Aristotle's logic was then felt as some kind of intrusion on this territory of the Arabic grammarians, and this was so tense, or such a big thing, that even a public hearing, or a public discussion, was organized in the year 932 between Abū Bišr, who represented Aristotelian logic, and the most renowned grammarian of the time. Abū Bišr was under attack, so to say, and his defence was to think up the following formula: grammar is about expression, but logic is about meaning. We would say now, logic is about the meaning structure, or I guess we would say, logic is about the semantical deep structure as opposed to grammar, which is about the surface structure.

This is certainly something new in logic, at least I do not know of anything of that kind in Greek logic. It undoubtedly had to do with the fact that, whereas Greek logic and philosophy was a monolinguistic endeavour, they were faced with the difficulty of simultaneously having to deal with many languages, at least Greek, Syriac—which formed the intermediate between Greek and Arabic—Arabic, Persian, and maybe even more, but this is quite sufficient. This idea of having, so to say, an underlying language of thought, or of dealing with meaning structures having different manifestations in the different languages, in the usual sense of language, could hardly arise except in this polylinguistic situation in which they found themselves.

If you look at the transition in that light, it looks like a transition from the verbal to the mental, if you take judgement to be the mental counterpart of assertion. That is thus another possibility here, much less innocent than the other one.

I have one little place of support for this, or rather one place where you see the same kind of transition from say to judge, and this is in al-Farabi's commentary on the *De Interpretatione*. It happens to be from the ninth chapter, the sea battle chapter, but I just want to show you what takes place. Here is Aristotle:[2]

> (18b33–34) For there is nothing to prevent someone from *saying* of some thing that it will be in, say, ten thousand years, while someone else *says* that it will not.
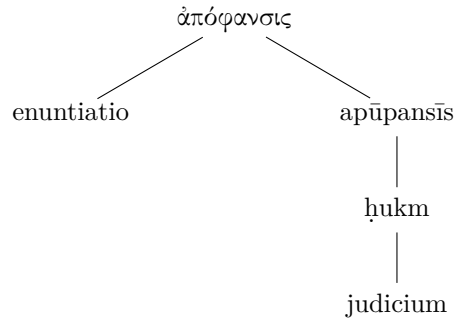
When al-Farabi discusses this, he says,

> There is nothing to prevent that someone should have deliberated on something and come up with the *judgement* that it will be in a

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> very long time [...] and that someone else should have deliberated
> on it and, as a result, come up with a *judgement* that it will not.

You have the same passage here from say to judge in al-Farabi's text, and these are texts that certainly were known to subsequent logicians.

We have now looked at the Arabic phase of this question and seen that, indeed, the term judgement, ḥukm in Arabic, was introduced in order to translate Aristotle's ἀπόφανσις. But, as I said a moment ago, the translation did not go directly from the Greek into the Arabic: there is an intermediate Syriac phase—the Arabic translations were made from Syriac, not directly from the Greek. Hence there is the question, If we go back to this Syriac phase, do we find the term judgement already there? We know that we do not find it in the Greek phase, but it could possibly have been in the Syriac phase. Again we are in the right place in Paris, because here there is what seems to be the foremost expert on the Syriac transmission of Aristotle's logic, namely Henri Hugonnard-Roche, who has provided me with necessary information about the Syriac phase. The picture that we arrive at is the following.

$$
\begin{array}{ccc}
& \text{ἀπόφανσις} & \\
& \diagup \quad \diagdown & \\
\text{enuntiatio} & & \text{apūpansīs} \\
& & | \\
& & \text{ḥukm} \\
& & | \\
& & \text{judicium}
\end{array}
$$

We have the Greek ἀπόφανσις, Aristotle's ἀπόφανσις, which is the origin. It was translated directly by Boethius into enuntiatio, and that we know because, although his *Analytica Posteriora* translation was lost, the *De Interpretatione* translation is there and has been there all the time, and there ἀπόφανσις is translated by enuntiatio. We may therefore take for granted that the three occurrences in the *Analytica Posteriora* were also translated by him by enuntiatio.

What happened in the Syriac? Well, the translation of Aristotle into Syriac began very soon after the Boethius translation, later in the 500s, in particular by Proba, or Probus in Latin. Apparently, there was no term for ἀπόφανσις in Syriac, so what to do? Well, you must then introduce a term that corresponds exactly to it, and they just transliterated it into apūpansīs—so it is just ἀπόφανσις written in Syriac as well as you can. And it remained that way during this whole Syriac phase, which is a period of 300 years, until Aristotle's logic moved from Antioch and arrived in Baghdad in the late 800s.

Clearly, then, there is no judgement during this Syriac phase, there is just a transliteration of the Greek. Judgement appears when the Syriac apūpansīs was translated into Arabic, and that is known, in the case of the *De Interpretatione*, to have been done by Isḥāq ibn Ḥunayn. I think we have all heard about the translator school in Toledo in the 1100s, because they gave us the Arabic science

and philosophy. There was a similar situation in 800 in Baghdad, namely they got Greek philosophy and science through translation. There was a translation school in Baghdad at that time, whose most prominent man is Ḥunayn ibn Isḥāq, the father of this school. Concerning these particular texts where you have judgement, namely *De Interpretatione*, it is known that Ḥunayn himself translated it into Syriac, and Isḥāq ibn Ḥunayn, his son, rendered it into Arabic—which means that we also know approximately when this took place [see Appendix 1]. That is the moment when the term judgement appears: his choice of ḥukm to render the Syriac apūpansīs, which is just Aristotle's ἀπόφανσις. Ḥukm was in turn translated, in the case of the *Analytica Posteriora*, by judicium in the Gerardus translation, and so we got it into Latin.
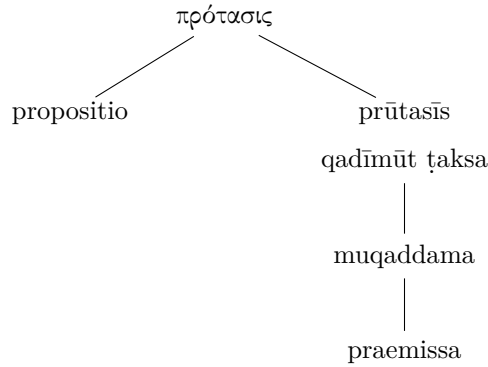
This is itself an interesting phenomenon, that we have two transmission ways of Greek logic and philosophy in general, namely the direct and the indirect one. In the case of Aristotelian logic, the direct transmission to the West is through the Boethius translations, which in this case gave us enuntiatio. The other transmission way, in the East, goes through this Syriac tradition for 300 years, continuing in Arabic for another 200–300 years, and then reaches us through the Toledo translators in the middle of the 1100s, which is to say a bit more than 600 years later than we got enuntiatio.

This development left us with two terms for one and the same term in Aristotle. What happens in such a situation when we have two words which ought to have the same meaning because they come from the same source? Well, either, one of them dies—this is a kind of linguistic law, which I do not know the name of: two different words with exactly the same meaning do not survive beside each other, that just complicates communication, so one of them dies—or else a meaning difference is developed between the two, and they both survive. In this case I think it is the latter that happened, namely that judicium came to be reserved for the mental act of judging, whereas enuntiatio was for the verbal act of assertion. In French you are lucky to have énonciation as a living word. In English it has died, enunciation is impossible for us to use now, so assertion in English, but in French the best is to stick, I guess, to énonciation.

A meaning difference has thus developed: one for the mental and the other for the verbal. This in fact goes back already to the Arabic time. Although the term ḥukm was introduced, as I said, as the first translation of ἀπόφανσις, very soon afterwards, namely with al-Farabi, in particular with the text that I have just showed you, his commentary on the *De Interpretatione*—he did not stick to the ḥukm-translation, but rather changed it into qaḍiyya, a term that had been used already in the first Arabic logic, from the middle of the 700s by Ibn al-Muqaffa. Since al-Farabi chose qaḍiyya instead, he had two terms: ḥukm and qaḍiyya. As we already saw in the passage that I showed you, he used ḥukm in his own discussion of Aristotle's text, and used it in a way that is, to me at least, indistinguishable from the way we use judgement in our tradition: I judge it to be sunny today, and such things. So, the distinction in Arabic that you have between qaḍiyya and

ḥukm is essentially the same as the distinction between enuntiatio, corresponding to qaḍiyya, and judicium, corresponding to ḥukm.

This is the result of my investigation concerning judgement, and it immediately suggests that we have a similar pattern with respect to another difficult logical term as regards its history, namely proposition and premiss.

$$\pi\rho\acute{o}\tau\alpha\sigma\iota\varsigma$$

propositio   prūtasīs
                                       qadīmūt ṭaksa

muqaddama

praemissa

Propositio is Boethius' translation of Aristotle's πρότασις, and we did not get the term premiss until the latter part of the 1100s. It is just a fact that Aristotle had a word for conclusion, namely συμπέρασμα, but there was no special term for premiss in Aristotle, there was just the term πρότασις for proposition. How did we then get the term premiss? We got it because πρότασις was rendered into Syriac, and in this case in two different ways, and I need not comment on the second here—I could do that in the discussion—but to begin with, it was just transliterated as prūtasīs. This was then translated into muqaddama in Arabic, and then finally, although not by Gerardus Cremonensis, but by—there were many translators of Arabic into Latin in the second half of the 1100s, and in this case Prantl refers to a certain pseudo-Averroës. I have also checked with the translation into Latin of Avicenna's *Metaphysics*, and in both cases you find praemissa as a rendering of the Arabic muqaddama.

This is how we got the important term premiss: one origin, but two different ways producing two different terms. Here it is maybe even more clear than in the other case that they both survived, because there was a great need for the notion of premiss. It survived by developing a very clear meaning difference. I mean, there is no way of mixing up proposition and premiss, in present-day logic we all know the difference.

When I had reached this final conclusion, Henri Hugonnard-Roche very kindly provided me with two reprints of his,[3] which are about Gerardus Cremonensis and what we owe to him in the way of logical and philosophical terminology. In both of these two articles, you find the following formula:

$$\text{judicium (ḥukm} = \mathrm{\mathring{\alpha}\pi\acute{o}\varphi\alpha\nu\sigma\iota\varsigma)}$$

[3] "Les oeuvres de logique traduites par Gérard de Crémone" in *Gerardo da Cremano* edited by P. Pizzamiglio, Cremona, 1992, pp. 45–56, and "La tradition syro-arabe et la formation du vocabulaire philosophique latin" in *Aux origines du lexique philosophique européen. L'influence de la Latinitas*, edited by J. Hamesse, Louvain-la-Neuve, 1997, pp. 59–80.

which is to say that Gerardus Cremonensis gave us judicium, which corresponds to the Arabic ḥukm and the Greek ἀπόφανσις. So the conclusion that I have reached is not new, but well known to the real experts. It has, however, not reached as far as the circle of logicians, not even the historians of logic—if you think of Kneale's history of logic or Bocheński's history of logic, this information is certainly not to be found there. So at least I hope with this to have contributed to making this knowledge more widespread.

Appendix 1: Timeline

> Proba (second half of the sixth century)
> Ibn al-Muqaffa (c. 750)
> Ḥunayn ibn Isḥāq (809–873)
> Isḥāq ibn Ḥunayn (c. 830–910)
> Abū Bišr Mattā ibn Yūnus (c. 870–940)
> al-Farabi (c. 870–950)
> Avicenna (c. 980–1037)
> Gerardus Cremonensis (1114–1187)
> Averroës (1126–1198)
> Robert Grosseteste (c. 1170–1253)
> Albertus Magnus (1193/1206–1280)

Appendix 2: Abstract of the seminar 'Logic, epistemological or ontological?'

What is logic? Is it the study of the process of inference or reasoning, called demonstration in mathematics, by means of which we justify our judgements? Or is it the study of the logical and set-theoretical concepts, like proposition, truth and consequence on the one hand, and set, element and function on the other, that make their appearance in the contents of our judgements? This is the fundamental question whether logic is in essence, or by nature, epistemological or ontological. The answer is presumably that it is both, which is to say that, within logic, one can distinguish between two parts, or two layers, the one epistemological and the other ontological. But there remains the question of the order of priority between these two layers: Which comes first? Is epistemology prior to ontology, or is it the other way round? Bolzano, whose logic in four volumes, called *Wissenschaftslehre*, has the most clear architectonic structure of all logics that have so far been written, treated of the ontological notions of proposition, truth and logical consequence (*Ableitbarkeit*) in the first two volumes of his *Wissenschaftslehre*, relegating the epistemology to the third volume. Thus he let ontology take priority over epistemology. Although the line of demarcation between the two was drawn in exactly the right place by Bolzano, my own work on constructive type theory has forced me to the conclusion that the order of priority between ontology and epistemology is nevertheless the reverse of the order in which they are treated in the *Wissenschafts- lehre*. The epistemological notions of judgement and inference have to be in place

already when you begin to deal with propositions, truth and consequence, as well
as with other purely ontological notions, like the set-theoretical ones.