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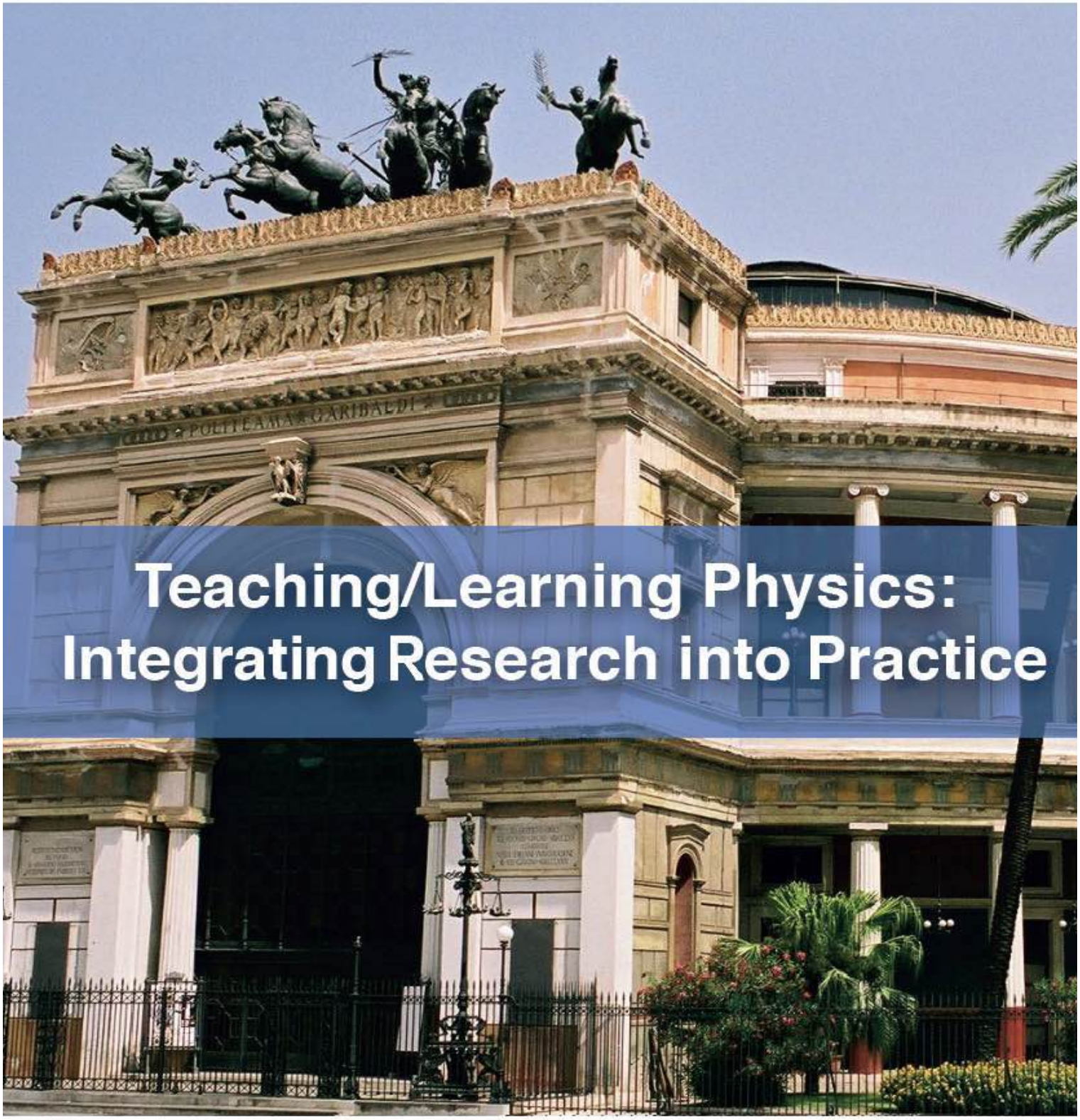

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On the Verdict of the German Physical Society Against the *Karlsruhe Physics Course* – a Chronicle of Events

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Abstract
The *Karlsruhe Physics Course* (KPC) is a novel approach to the teaching of physics at the secondary school. It was developed more than 30 years ago. The KPC textbooks have since been used in a certain, slightly increasing number of German schools. Simultaneously, ideas of the KPC have found their way into the mainstream textbooks. Only recently, the German Physical Society (DPG) got aware of the course. In their opinion the KPC represents a danger to the teaching of physic. Therefore, the DPG nominated an expert panel with the assignment of finding scientific errors in the KPC. The panel believed to have found such errors. Thereupon the DPG has initiated a campaign with the objective of eliminating not only the KPC textbooks from the market but to eradicate any other manifestation of ideas that might have originated in the KPC work. The DPG did so not only in Germany but worldwide. Among other things, the DPG alerted the European Physical Society and the Chinese Physical Society. As a result of these measures, a discussion of unusual fierceness arose, first in Germany, but then spreading to other countries. Thereby the physics community got more and more polarized. A chronicle of an eventful year and a brief evaluation will be given from the perspective of the author of the course and of a teacher who uses the KPC in his classes.

Keywords
German Physical Society, Karlsruhe Physics Course

1. Introduction

It is our intention, to inform about some events that have shaken the physical community in Germany and that have also emanated into some other countries; we believe that they concern all of us physics educators.
It is an attack of the German Physical Society (DPG) against a teaching concept developed by our group, the Karlsruhe Physics Course (KPC) [1,2]; it is an attack against a large group of scientists and teachers, but it is also an attack against the whole community of physics education researchers.

2. The genesis of the KPC

The development of the KPC began in 1975. At that time the *Nuffield course* and the *PSSC* existed already. Our ambition was to develop a new physics course, to modernize the teaching structure or doctrine of physics, in the first place not for a particular group of addressees. That is why the first tests of each subfield that we were occupied with, was not with a school class, but with university students of physics. Thereafter, we simplified, shortened, boiled down the course for the higher and the lower secondary school. Only in this way it was assured, that the school version could serve as a solid basis for any follow-up course.
Here briefly some characteristics of the KPC.

- Today's science curriculum is the result of a process of evolution. It reflects the historical development of the physical science in great detail. Those who are learning science have to follow a path that is similar to the course of the historical development. Our students have to take detours, to overcome unnecessary obstacles and to reproduce historical errors. They have to learn inappropriate concepts and employ outdated methods. When developing the KPC we have tried to eliminate such obsolete concepts and methods.
- The KPC makes use of analogies. The most important one is an analogy based upon the extensive quantities: Electric charge, momentum, entropy and amount of substance.

As a result the KPC is more compact than traditional courses. We also believe that it is easier to learn physics with the KPC. All the conceptual changes that were used in the KPC have been published [3],

mainly in the *American Journal of Physics* [4-9] and in the *European Journal of Physics* [10-16]. Many details have been presented at previous GIREP meetings.
When developing the Secondary school version, every subject and every new idea was tested at school by ourselves under real class room conditions. A version for the lower secondary school was ready in 1988. At that time we began with a test of the course at 20 selected schools, which lasted 3 years. The test procedure was supervised by the Ministry of culture of the Federal State of Baden-Württemberg. The test was satisfying in every respect. The school authority had looked in particular if there are problems when a pupil changes from a KPC class to a traditional class and vice versa. In 1994 a new official curriculum entered into force, which contained a special clause that allowed every school to use the course upon application.
In the years from 1996 to 2001 the KPC was evaluated in a PhD theses at the IPN at Kiel (Leibniz Institute for Science and Mathematics Education) [17].
In 2004 finally it got the definite approval as a schoolbook in Baden-Württemberg. In the following years ideas of the KPC entered the new education standards; textbooks of other authors took over KPC ideas.
The course was translated into foreign languages, among them Italian, English and Chinese.

3. The reception of the KPC

How did the various communities receive the KPC ideas?
There are teachers, at school and at the University, who do not like changes of the basic concepts. In political terms one would call them *conservatives*. There are other colleagues who see the deficiencies of the traditional curricula and who are more open for innovations. Let us call them the *reformers*. In the case of the KPC a very strong polarization between these two groups developed. On one side there were the passionate supporters, on the other there were the equally passionate opponents. But the intensity of the reactions, the emotionality of both sides has surprised us a lot. Let us consider the reactions of four different groups or communities.

1. The secondary school scene, i.e. school teachers and teacher educators.
Here, a fierce discussion was going on in the nineteen-nineties. Finally in 1998, the MNU, our association of science teachers, organized a symposium: A dispute between conservatives and KPC defenders. Each of the two groups was represented by one theoretical physicist from the University, one experimentalist, one school specialist and so on. A protocol was written and published in the Web, where it still is [18]. This symposium had attested that the KPC does not contain scientific errors.

2. The educational branch of the DPG.
Here, the KPC was known more or less. Not all of the colleagues were enthusiastic about it. In the terms mentioned above, one would classify most of them as conservatives. The majority of them is working on less offensive subjects. Some made us feel that we not really belonged to them, since what we made is in their eyes rather physics than physics education.

3. The much greater non-educational part of the physics community.
The general physics community did not know our work. Why should they? Only some of them, mainly former students of the author of the KPC, knew the KPC. Some of them had become university professors in the meantime and they used KPC ideas in their lectures. Others had heard about our work and they took a rather clear position: “I know how to teach physics, I do not need recommendations from the educational people.”

4. Other countries.
The KPC work got also known in other countries, at the beginning mainly in several latin-american countries, like Chile, Argentina and Colombia. In Europe it got known mainly in Switzerland and Italy, and since about 10 years it was tested and introduced at some Chinese schools. Recently it got the approval as an official schoolbook in the province of Shanghai.

4. The report of the DPG

In 2011 the DPG elected a new executive board. Apparently, members of the board had been alerted by opponents of the KPC about the spread of the course. The board got aware, that the KPC is not simply one among many other school projects. They discovered that the KPC has found a considerable resonance at schools. They got aware that there must be physics students at their own faculties who have been educated by teachers with a KPC background. And they discovered that KPC ideas have found their way into the official school curricula; they also got aware that teacher educators were spreading the ideas and that KPC

ideas have made their way into the mainstream textbooks.
From the beginning they were convinced, that the KPC contains scientific errors. The logic might have been like this:

> "The KPC is different from what I am teaching; what I am teaching is correct; thus the KPC is not correct."

Therefore, the DPG board nominated an "expert panel" consisting of 13 persons. The assignment of the panel was to search for errors in the KPC. Its composition was somewhat unusual: Four of the members were members of the DPG board, in other words, they nominated themselves. One of the panel's members was an Ombudsman of the DPG, who, according to the statutes of the DPG should not take upon any other activity: *"The ombudsmen and ombudswomen may not exercise any other function in a DPG body during their period of office, so that they are able to reach their decisions with a maximum of independence."* It is also conspicuous that none of the members came from the educational section of the DPG. On the contrary, the educational colleagues were accused, that they had not recognized the danger that the KPC represents, and that they had not "alerted" the directory board of the DPG.
So, the panel members looked for mistakes, and they were successful – at least that is what they believed. They published their report in the Internet on February 13, 2013 [19]. A letter dated the same day was sent to the author of the KPC.
Our first reaction was an immediate relieve. After reading the report, it was clear that none of the allegations could be substantiated. Most of the claims of the DPG experts were based on ideas that are scientifically incorrect, others accuse the KPC to contain statements that it does not contain. It was obvious, that the DPG experts had not taken the time to study the KPC carefully. Moreover, the wording of the report was insulting.
Every innovative idea of the KPC had been published previously in one of the great international peer-reviewed journals. None of these publications was mentioned in the report, and apparently none of the experts had read any of them.
Several of the allegations refer to ideas that can be found in prestigious textbooks, like Landau-Lifshitz or Feynman. Several allegations refer to ideas that had originally been published by scientists like Maxwell or Planck. The report makes no reference to this work, although it is in contradiction to it.
Although the report is long and it is rather difficult to follow the twisted thoughts of its authors, it can be seen that the problems they see, are mainly based on a general misunderstanding. The DPG experts confuse two concepts: that of a physical quantity and that of the object or system described by the quantity. In other words: they confuse theory and reality.
There are three main allegations and we will discuss them briefly.

1. Force as momentum flow
In mechanics, the primary quantity in the KPC is momentum. Consider two bodies A and B, that are connected by a spring. When the momentum of A increases at the expense of the momentum of B, the traditional wording is: A exerts a force on B and B on A. The KPC description is: momentum is going or flowing from B to A.
Here the opinion of the DPG panel:

"This current does not exist in nature. For this reason the KPC momentum current has no place in the existing framework of physics and most certainly not in physics classes."

Notice, that with this claim, the DPG panel members not only call into question the KPC. In the first place they disagree with Max Planck, who, in 1908 introduced the concept of momentum flow. We quote from Planck [20]:

> "As the constancy of energy entails the concept of an energy flow, the constancy of the quantity of motion necessarily entails the concept of the flow of the quantity of motion, or for short the 'momentum flow'."

The DPG report is also in disagreement with some of the best University textbooks, as for instance Landau-Lifshitz [21,22].

2. Entropy and the colloquial concept of heat
At the beginning of the chapter about thermodynamics, on the second page, KPC says:

> "What we call 'quantity of heat' in everyday language, has a special name in physics. It is called *entropy*. The symbol used for entropy is *S*… "

And here the objection of the panel:

"It is true that the entropy of a system can be changed by supplying or removing heat. But entropy is by far not the same as heat, and cannot be referred to as such, not even 'colloquially'. Both have different measurement units, simply for this reason they cannot be identical. Heat is measured in Joule, entropy in Joule / Kelvin."

Our answer: The colloquial heat has no unit, it is not measured in Joule.

And later the panel:

> "KPC's assertion that entropy is 'colloquially called heat' is wrong and misleading in a particularly blatant manner…"

Notice the wording. The style of the whole document is pretentious, aggressive and insulting.

Yet another quotation from the report:

> "It is well-known that entropy is one of the most difficult physical quantities."

This is indeed a widespread opinion. However, the opposite opinion is also widespread. Let us quote the British physicist *Callendar,* from the Royal College of Science. In 1911 he wrote [23]:

> "Finally, in 1865, when its importance was more fully recognised, Clausius gave it the name of 'entropy', and defined it as the integral of *dQ/T.* Such a definition appeals to the mathematician only. In justice to Carnot, it should be called caloric, and defined directly by his equation $W = S\ (T - T_0)$, which any schoolboy could understand. Even the mathematician would gain by thinking of caloric as a fluid, like electricity, capable of being generated by friction or other irreversible processes."

3. Magnetic charge

The KPC operates with the physical quantity magnetic charge. Here the opinion of the DPG experts:

> "Contrary to this experimentally verified fact, […] the KPC assumes in the textbook […] the existence of magnetic charges"

Magnetic charge was introduced by Maxwell in his *Treatise* [24] and it is also introduced in other text books [25]. Sometimes it is called magnetic pole strength. The quantity is needed in order to express quantitatively the fact that a magnet has two poles which in its action are equal and opposite: Each pole carries magnetic charge; the amounts are equal, the signs are opposite. The quantity is also needed in order to express the fact that no magnetic monopole particles exist.

In this context, the teacher's manual of the KPC explains, that physical quantities are creations of the human mind. This statement is commented by the DPG referees as follows:

> "Now this is an argument which discredits completely the action of the KPC in the eyes of reputable scientists. This is an evident example of how the KPC bends basic physical facts in favor of didactic convictions."

So far the report. It had been published in the internet, but this was only the beginning of a large campaign.

5. The measures of the DPG

Ministries

On March 1, 2013 the president of the DPG writes letters to the ministries of culture and education of all the 16 German federal states, from which we quote:

> "The Karlsruhe Physics Course is unsuitable for use in schools and will cause damage if its diffusion continues.… The German Physical Society believes, therefore, that the Karlsruhe physics course may not be used to teach physics in school or as a guideline for the formulation of physical education or training plans."

Also on March 1, the president of the DPG asks the deans of the physics departments of the German

universities, not to comment on the KPC case:

> "Hereby we would like to inform you about the report, since it may be that you are asked questions about it from various sides. At the same time I ask you not to become active independently, so that the measures of the DPG on the political level and regarding the public relations can be concerted."

The European Physical Society
On April 5 the European Physical Society (EPS) is informed by the German delegate to the EPS council, who simultaneously is a member of the DPG-KPC panel. He warned the EPS council against the KPC. To do so, he had prepared a PowerPoint presentation. We cite from the last slide:

> "Please contact me or the DPG office if you notice that KPC based teaching is used at your schools or universities. DPG will supply you with the necessary arguments and materials to counteract this development which is damaging to the reputation of our field and to the necessary improvement of Physics teaching at all school levels."

Apparently, the German delegate does not trust in the physical competence of his European colleagues.

The Chinese Physical Society
On April 12 the president of the DPG warns the president of the Chinese Physical Society:

"The findings [of the report] point to substantial mistakes contradicting our internationally established knowledge of physics. The panel strongly recommends that the course should not be used for teaching physics at schools. I have been informed that the course is now also in use in your country, for example at the Jinshan-School in Shanghai. …"

The president appended to this letter the ppt slides that was mentioned just before and that had been used to inform the European Physical Society.

Ombudspersons
Since in our opinion the DPG had infringed the rules of good scientific practice, we wanted to address to an ombudsperson of the DPG. There are two of them. The first one was out of question, because he was a member of the KPC panel. So we addressed to the second one, a Lady. First, she did not answer to two of our e-mails. Finally we succeeded getting her on the phone, where she told that this was not the right way to open a procedure. If she is to occupy with a case, the initiative has to come from the directory board of the DPG. After explaining her that the Board was one of the contentious parties, she reluctantly promised to look at the case. Soon after, we received an e-mail, where she said, that the case was not a case for the Ombudsperson. But in addition, she wrote some words of consolation:

> "From my point of view, here is a controversial discussion about the KPC - comparable to the critical review of a book."

6. The damage

Our publisher (the AULIS-Verlag) had just prepared a new improved edition of some of the volumes of the KPC. However, on April 4, before the new books appeared in print, the author of the KPC was advised that the publisher discontinued the cooperation.
Some years ago the KPC had been translated into Chinese. It had been tested in some selected schools. The teachers had been trained by us. Every year we passed some weeks in Shanghai. Reports about the experience with KPC teaching had been written and several symposia had been organized. After the test had been considered a success, it was decided to make a new KPC type book, written by Chinese authors: a version that fits better into the Chinese educational system.
Just like in our country, every new schoolbook has to be approved by the school authority. This certification process was just beginning, when the letter of the president of the DPG arrived. Thereupon, the certification process was discontinued.

7. First reactions

School teachers, teacher educators, university professors
The publication of the DPG report triggered an avalanche of responses, statements, comments, letters of protest, resolutions, collections of signatures. All of them demand the withdrawal of the DPG review.
It was the subject at many meetings, and meetings have been specially organized to discuss the affair: faculty

councils, a meeting of the deans of the German physics faculties, meetings of teacher educators, of the educational section of the DPG.
The protest came from various communities: School teachers, teacher educators, University professors.
A great part of the material has been published in the internet [26].

The educational section of the DPG
The members of the educational section of the DPG not only disagree about the DPG measures against one of the most innovative educational projects, they also feel duped, since the DPG had assigned a commission to assess an educational project, in which none of the specialists of education was present.

The European Physical Society
The DPG had also alerted the European Physical Society (EPS). We have mentioned above the PowerPoint file that had been used to inform the committee.
The president of the EPS has addressed a letter to the national physical societies.
The author of the KPC wrote an e-mail to him asking, if there is an official reaction of the EPS, and he answered:

> "The EPS has not published an official position on the Karlsruhe Physics Course (KPC). Nonetheless, we did commission an independent review of the KPC, which is in broad agreement with the position of the DPG. The EPS Executive Committee has expressed its support to the DPG for its handling of the matter."

The KPC author asked the president of the EPS to give him, the person that is most concerned, access to this review, but the EPS president did not answer anymore.

Miscellaneous reactions
Several persons terminated their membership of the DPG, among them several University professors. Some colleagues wrote scientific articles in support of the KPC concept.
Many persons expressed their concern in e-mails that they sent to the author of the KPC, and they sent letters of encouragement. In several of these letters the sender formulated: "I am ashamed to be a member of a society…"

8. Recent events
Apparently, the DPG had been surprised by the intensity of the reactions. They had believed that they could easily eliminate the KPC once and forever. Since it was not so easy, they started a campaign in order to bring the various groups "to the party line". Meetings took place in various cities. The result was always the same: None of the two sides moved one iota.
In the meantime, many people had heard and discussed about the KPC, people, who had not known anything about the KPC before.
A great number of DPG members considered the lapse of the DPG harmful for the reputation of the society. They wanted the report to be withdrawn. In particular, a group of 21 theoretical physicists of high reputation, several of them award winners, wrote a manifest, asking the DPG to withdraw the report:

> "*Declaration:*
> The signatories declare that they do not agree with the criticism formulated in the report and in the supplement. They consider the examples, that are to prove that the KPC contains "experimentally detectable false statements" unfounded. Therefore, they dissociate from the recommendation of the DPG Executive Board given in the name of the DPG members. They ask the DPG Board to withdraw the recommendation with immediate effect."

But also this initiative had no effect. Since there was no easing of the tension, the DPG invited the theoretical physicists group to a discussion meeting. It took place on January 10 in a conference room at Frankfurt Airport.
However, also at this meeting both parties repeated the statements, opinions and claims that they had already published previously. It was obvious that for the DPG there was no turning back.
Finally, this March 17, the KPC was on the agenda at a DPG general assembly. There, the report was submitted to a formal vote. There was a great majority in favour of the DPG activities. Apparently, the majority of the participants of the meeting did not know the KPC. The president of the DPG argued that an expert commission had found substantial errors in the course. It is natural, that the vote was in favour of the DPG board.
Thereafter, the controversy slowed down. The DPG opponents were tired and frustrated. The DPG had not

really attained its goal. They had started a year before with the conviction to be able to erase or extinguish any manifestation of KPC related ideas. Instead, their activity became a publicity campaign for the KPC, which we would never have been able to realize ourselves. KPC related physics is discussed more than ever in seminars and teacher training courses.
Finally we were informed by our publisher in Shanghai that the KPC was, with a delay of one year, approved as a schoolbook in China.

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