

# The bibliographical route of Francis Halbwachs: A personal comment

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## ABSTRACT

*This article is a bibliographical survey of the work of Francis Halbwachs. This work is divided into three distinct periods. The first period concerns his research activity in the field of Theoretical Physics. The second period relates to the years of his collaboration with the International Institute of Genetic Epistemology in Geneva. The third period of his work refers to his activity as a researcher in the field of science education.*

## KEYWORDS

*Francis Halbwachs, bibliographical survey*

## RÉSUMÉ

*Cet article est une étude bibliographique de l'œuvre de Francis Halbwachs. Ces travaux sont divisés en trois périodes distinctes. La première période concerne son activité de recherche dans le domaine de la physique théorique. La deuxième période concerne les années de collaboration avec l'Institut international d'épistémologie génétique à Genève. La troisième période de son travail se réfère à son activité de chercheur dans le domaine de la didactique des sciences.*

## MOTS-CLÉS

*Francis Halbwachs, étude bibliographique*

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## INTRODUCTION

The bibliographical presentation of Halbwachs' multifaceted work can be divided into three distinct research periods, each of which corresponds to an independent research activity. The first period concerns his research activity in the field of Theoretical Physics. The second period relates to the years of his collaboration with the International Institute of Genetic Epistemology in Geneva, where his main research activity consists in correlating the historical development and psychogenetic development of scientific knowledge and especially of knowledge in Physics. The third and last period of his work refers to his activity as a researcher in the field of Science Education which he pursues as a Professor at the Université de Provence (now Université d'Aix-Marseille). It should be noted that these are not chronological periods and that there are several papers whose content contains elements that come from two (e.g., many of the papers in the third period) or even three (e.g., paper [57]) research periods. These papers have been placed in in that period the research activity of which we consider to be the predominant one in the content of this paper. The full text of some papers can be retrieved from the Springer Nature website<sup>1</sup> (including articles belonging exclusively to the first period) and the PERSÉE website<sup>2</sup> which is supported by the French Ministry of National Education, Higher Education, Research and Innovation (including articles belonging to all three periods).

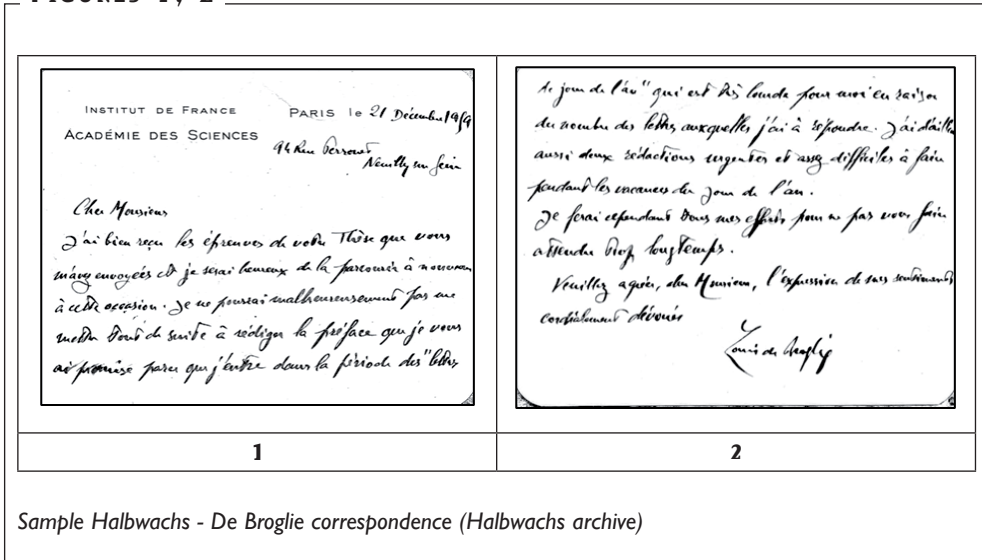
## FIRST RESEARCH PERIOD

Halbwachs supported his PhD thesis in Theoretical Physics in 1958 and worked at the CNRS from 1956 to 1966 under the guidance of Nobel Prize-winning physicist Louis de Broglie, known for his wave-particle duality theory of matter, who also wrote the preface to the publication of this study [8]. In this study the special relativistic theory of a fluid with non-vanishing internal angular momentum is examined from various points of view. Figures 1 and 2 show a sample of the correspondence developed by Halbwachs and De Broglie and Figure 3 shows the cover page of his published thesis.

1 <https://link.springer.com/search?new-search=true&query=Halbwachs+F&dateFrom=&dateTo=&contributor=F.+Halbwachs&sortBy=relevance>

2 <https://www.persee.fr/authority/83596>

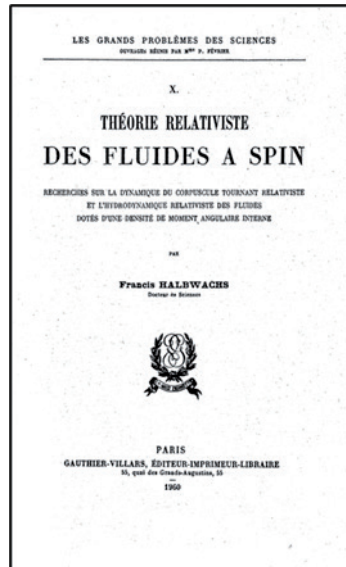
FIGURES 1, 2



There are several individual or group publications related to the topic of his thesis ([4], [5], [6], [7], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [26], [27]). At the same time, however, he also develops an authorial activity in the field of Philosophy of Physics, not only to defend and disseminate the realistic and deterministic epistemological conception of his work in Quantum Physics (as opposed to the instrumentalist and probabilistic conception of the Copenhagen school) ([2], [3], [23], [24]), but also to highlight the social role and humanistic dimension of Physics ([22], [25]).

A lesser known aspect of Halbwachs' work is where he explores the relationship between Physics and the dialectical materialism. His 1946 paper [1] is typical of this research activity, while an unpublished manuscript of about 200 pages entitled *Marxisme et sciences physiques* [73] was retrieved from his archives, the study and analysis of which would be of particular interest for historical reasons. Finally, in the same period we also classify his two-volume educational textbook addressed to high school graduates who are preparing for an entrance examination for higher education [21].

FIGURE 3



The cover of the published doctoral thesis of F. Halbwachs

1. Halbwachs, F. (1946). *Matérialisme dialectique et sciences physicochimiques*. Paris: Éditions Sociales.
2. Halbwachs, F. (1955). Une tentative pour édifier une microphysique matérialiste. À propos de la thèse de Jean-Pierre Vigier. *La Pensée - Revue du rationalisme moderne*, 61, 36-48.
3. Halbwachs, F. (1957). Nouvelles perspectives de la microphysique. In *Actes du IX Congrès des Sociétés de Philosophie de Langue Française «L'homme et ses œuvres»* (pp. 212-217).
4. Halbwachs, F., Hillion, P., & Vigier, J. P. (1958). Lagrangian formalism in relativistic hydrodynamics of rotating fluid masses. *Il Nuovo Cimento*, 10(5), 817-833.
5. Halbwachs, F., Hillion, P., & Vigier, J. P. (1959). Quadratic lagrangians in relativistic hydrodynamics. *Il Nuovo Cimento*, 11(6), 882-883.
6. Halbwachs, F. (1959). Rotation instantanée et angle d'Euler dans l'espace-temps. *Annales de l'Institut Henri Poincaré*, 16(3), 145-160.
7. Halbwachs, F., Hillion, P., & Vigier, J. P. (1959). *Angles d'Euler, rotation instantanée et opérateurs quantiques de rotation dans l'espace-temps*. Paris: Gautier-Villars.

8. Halbwachs, F. (1960). *Théorie relativiste des fluides a spin. Recherches sur la dynamique du corpuscule tournant relativiste des fluides dotés d'une densité de moment angulaire interne*. Paris: Gautier-Villars.
9. Halbwachs, F. (1960). Lagrangian formalism for a classical relativistic particle endowed with internal structure. *Progress of Theoretical Physics*, 24(2), 291-307.
10. Halbwachs, F., Hillion, P., & Vigier, J. P. (1960). Internal motions of relativistic fluid masses. *Il Nuovo Cimento*, 15(2), 209-232.
11. Halbwachs, F., & Vigier, J. P. (1960). Lie relations associated with relativistic rotators and bilocal theory. *Il Nuovo Cimento*, 16(3), 576-578.
12. Halbwachs, F., Souriau, J. M., & Vigier, J. P. (1961). Le groupe d'invariance associé aux rotateurs relativistes et la théorie bilocale. *Journal de Physique et le Radium*, 22(7), 393-406.
13. Halbwachs, F. (1963). A new classification of elementary particles and resonances. *Il Nuovo Cimento*, 28(4), 695-705.
14. Halbwachs, F., & Vigier, J. P. (1963). Theoretical prediction of new heavy bosons (especially heavy K-mesons) in the frame of the rotator model of elementary particles. *Il Nuovo Cimento*, 30(1), 469-475.
15. De Broglie, L., Bohm, D., Hillion, P., Halbwachs, F., Takabayasi, T., & Vigier, J. P. (1963). Rotator model of elementary particles considered as relativistic extended structures in Minkowski space. *Physical Review*, 129(1), 438-450.
16. Halbwachs, F. (1965). Is there a "classical analogue" of Dirac's theory? *Il Nuovo Cimento*, 36(3), 832-836.
17. Bohm, D., Flato, M., Halbwachs, F., Hillion, P., & Vigier, J. P. (1965). On the "space-time character" of internal symmetries of elementary particles. *Il Nuovo Cimento*, 36(2), 672-675.
18. Halbwachs, F., & Mebkhout, M. (1965). Groupes de symétrie et groupes d'invariance interne dans la théorie des particules à interactions fortes. *Annales de l'Institut Henri Poincaré*, Section A, 2(1), 1-20.
19. Kihlberg, A., Müller, V. F., & Halbwachs, F. (1966). Unitary irreducible representations of SU(2,2). *Communications in Mathematical Physics*, 3, 194-217.
20. Halbwachs, F. (1967). The conformal group as a candidate for the relativistic extension of elementary particle symmetries. *Il Nuovo Cimento*, 49(4), 517-539.
21. Halbwachs, F. (1970). *Précis de Physique I et II*. Paris: Presses Universitaires de France.
22. Halbwachs, F. (1971). La science et l'humanisme. *Raison Présente*, 20, 89-114.
23. Halbwachs, F. (1972). Sur la théorie physique des probabilités. *Raison Présente*, 21, 101-109.
24. Halbwachs, F. (1973). Statut de la théorie physique, copie ou représentation? *Raison Présente*, 26, 75-83.
25. Halbwachs, F. (1976). À propos de deux thèses du livre du Dominique Lecourt sur Lyssenko. *Raison Présente*, 40, 101-109.

26. Halbwachs, F., Piperno, F., & Vigier, J.-P. (1982). Relativistic Hamiltonian description of the classical photon behaviour: A basis to interpret aspect's experiments. *Lettere al Il Nuovo Cimento*, 33(11), 311-316.
27. Halbwachs, F. (1985). Modèles hydrodynamiques de la Mécanique Quantique. In E. I. Bitsakis & N. Tampakis (Eds), *Determinism in Physics*, (pp. 229-237), Athens: Gutenberg.

## SECOND RESEARCH PERIOD

The second period of Halbwachs' research activity mainly includes those papers which appear to be the result of his collaboration with the International Centre for Genetic Epistemology in Geneva. To this collaboration Halbwachs contributes both his culture as a theoretical physicist and his philosophical ideas which are related to the birth of modern scientific knowledge and especially that of Physics. On the philosophical level, he emphasizes the concept of *causality* in Physics ([28], [29], [30], [31], [32]) since the psychogenesis of causal explanations is a central issue in the Geneva research program (Piaget & Garcia, 1971), always defending the epistemological approach of realism [45]. The two, in our opinion, most important moments of this activity appear with his writings which are included in the collective works *Les théories de la causalité* ([30], [31]) and *L'explication dans les sciences* [33], writings in which leading scientists such as M. Bunge, T. Kuhn, J. Piaget, R. Garcia, G.V. Henriques and others participate.

While he continues to write purely epistemological texts in the context of his collaboration with the Geneva group [35], he opens another debate on the *ontogeny* and *phylogeny* of scientific knowledge (Strauss, 1988), this time developing a research activity within the field of the History of Science ([37], [38], [40], [42], [43], [46], [47], [48]). In these papers he explores and analyses episodes in the constitution of scientific thought (mainly in the fields of Mechanics and Thermodynamics) of various scientists in the light of Cognitive Psychology. For example, through the semantic analysis of a historical text (Viviani's scholium), an attempt is made to reconstruct "the movement of [Galileo's] thought and to show that certain ideas exist and are effective at levels preceding and underlying their exact expression in words" ([43], [47]). We are also impressed by Halbwachs' particular interest in the historical approach of the concept of *energy* ([38], [40], [42], [46]). Indicative of this particular interest is the text [46] where he proceeds to an analysis of the "energetics doctrine", an old theory which is no longer accepted, elements of which he will use in his pedagogical research. This interest seems to arise from his attempt, by analysing the case of the conservation of energy, to specialize the more general interest which arises from the research activity of the Geneva group on the analogies which appear in the historical genesis and psychogenesis of more general conceptual systems such as the transfer of motion and the various forms of conservation (Piaget & Garcia, 1983). In his emblematic text *La pensée physique chez l'enfant et le*

savant [36] he clearly formulates his general theoretical scheme on the question of the relations between historical evolution and the psychogenesis of scientific knowledge. Of particular interest, too, are his papers, which are written in the context of the “logic of meanings” (“*logique des significations*”), a newer conceptual framework for analysing and explaining the features of cognitive construction (Piaget & Garcia, 1987), developed by the Geneva group in the early 1980s’ 80 ([41], [44]). Finally, in this period we have included some papers in which the ideas of the third period of Halbwachs’ research activity appear in seed ([43], [44]).

28. Halbwachs, F. (1966). Sur les problèmes de la causalité physique. *Raison Présente*, 1, 79-98.
29. Halbwachs, F. (1968). Équilibre et causalité physique. *Raison Présente*, 8, 81-96.
30. Halbwachs, F. (1971). Réflexions sur la causalité physique. In M. Bunge, F. Halbwachs, T. Kuhn, J. Piaget & L. Rosenfeld (Eds), *Les théories de la causalité* (pp. 19-38). Paris: Presses Universitaires de France.
31. Halbwachs, F. (1971). Causalité linéaire et causalité circulaire en physique. In M. Bunge, F. Halbwachs, T. Kuhn, J. Piaget & L. Rosenfeld (Eds), *Les théories de la causalité* (pp. 39-III). Paris: Presses Universitaires de France.
32. Halbwachs, F. (1972). Sur les problèmes de la causalité physique. In *Épistémologie et marxisme* (pp. 59-98). Paris: Union Générale d’Éditions.
33. Halbwachs, F. (1973). Histoire de l’explication scientifique en Physique. In L. Apostel, G. Cellérier, J. T. Desanti, R. Garcia, G. G. Granger, F. Halbwachs, G. V. Henriques, J. Ladrière, J. Piaget, I. Sachs & H. Sinclair de Zwart (Eds), *L’explication dans les sciences* (pp. 72-102), Paris: Flammarion.
34. Halbwachs, F. (1973). Autour de Jean Piaget une équipe réellement interdisciplinaire. *UNI Information*, 31, 1-4.
35. Halbwachs, F. (1974). Structure de quelques révolutions scientifiques en physique. *Raison Présente*, 32, 85-101.
36. Halbwachs, F. (1974). *La pensée physique chez l’enfant et le savant*. Neuchâtel: Delachaux et Niestlé S.A.
37. Halbwachs, F. (1974). Les fondements psychologiques de la Mécanique pré-galiléenne. In *Les Cahiers du Séminaire d’Histoire et Sociologie des Idées et des Faits Scientifiques*, 7. Marseille: Université de Provence.
38. Halbwachs, F. (1977). Le problème de la découverte des «possibles» dans l’élaboration des lois du choc au XVIIe siècle. *Bulletin de Psychologie*, 327, 240-246. [B. Inhelder & F. Bresson (Eds), *Hommage à Jean Piaget*].
39. Halbwachs, F. (1979). Faut-il tuer les cardinaux ? Remarques d’un profane. *Revue Française de Pédagogie*, 46, 5-9.
40. Halbwachs, F. (1980). Histoire de l’énergie mécanique. *Cuide*, 17. Université Paris VI.

41. Halbwachs, F. (1981). Significations et raisons dans la pensée scientifique. *Archives de Psychologie*, 49, 199-229.
42. Halbwachs, F. (1981). Histoire de la chaleur. *Cuide*, 18. Université Paris VI.
43. Halbwachs, F. (1981). À l'aube de la Mécanique classique. In *Actes des Journées sur l'Éducation Scientifique (Chamonix)* (pp. 35-40), CNRS-INRP.
44. Halbwachs, F. (1981). Apprentissage des structures et apprentissage des significations. *Revue Française de Pédagogie*, 57, 15-21.
45. Halbwachs, F. (1983). Note sur la nécessité en Physique. *Communication & Cognition*, 16(4), 357-378.
46. Halbwachs, F. (1983). La «doctrine» énergétiste. In *Cahiers de la Fondation Archives Jean Piaget*, 4 (pp. 217-242), Centre Internationale d'Épistémologie Génétique.
47. Halbwachs, F., & Torunczyk, A. (1985). On Galileo's writings on Mechanics: An attempt at a semantic analysis of Viviani's scholium. *Synthese*, 62, 459-484.
48. Table ronde sur les thèses de Jean Piaget par les membres du Centre International d'Épistémologie Génétique. In B. Inhelder, R. Garcia & J. Vonèche (Eds), *Épistémologie génétique et équilibration* (pp. 115-119), Neuchâtel: Delachaux et Niestlé.

### THIRD RESEARCH PERIOD

Halbwachs, now a professor at Université de Provence but also a member of the Lagarrigue Committee, which was created in the 1970s to drastically reform the French school curricula, enters the third period of his research activity, contributing himself to the birth of the research current that we characterize in this special issue as the *francophone version of Science Education (Didactics of Science)* (Johsua & Dupin, 1993). First of all, he is actively involved in the dissemination activities of the new Science Education current and the objectives and content of the new curricula, writing both at the level of research and at the level of teacher training ([51], [52], [53], [63], [72]).

Another series of texts is devoted to the attempt to link his ideas on the design of science teaching content with his basic epistemological positions on the ontogeny and phylogeny of scientific knowledge ([50], [56], [57], [58], [67], [69], [71]). In his seminal text *La physique du maître entre la physique du physicien et la physique de l'élève* [50] he highlights the epistemological differences between scientific knowledge of *reference* and scientific knowledge as an *object of instruction* (Dupin, 2025).

In a very interesting paper, which Halbwachs co-authored with the psychologist Gérard Vergnaud, he states that “Didactics [of science] must necessarily be based on a good knowledge of the subject taught, of Cognitive Psychology and of the History of the subject, and that the issues and methodology it must develop can in turn raise important questions for psychology, for the epistemology of the subject, and for the subject itself” [56, p. 14]. In a supplementary paper ([57]) he elaborates these positions



through the example of the conservation of heat considered as substance explaining that this concept seems to be constructed both historically by Joseph Black and psychologically by young children, while at the same time expressing the heretical idea of introducing this concept into teaching at a particular educational level. The idea of introducing erroneous scientific theories into teaching is also expressed around the same time by Jean Marc Lévy-Leblond, another emblematic figure in the field of Physics (Lévy-Leblond, 1980). In this work it is quite impressive that we can identify all four fields of ideas with which Halbwachs has been involved (Physics, when he explains the difference between the concepts of “invariant” and “constant”, the History of Physics, when he describes the birth of the concept of the constancy of the quantity of heat, Genetic Epistemology, when he analyses the Piagetian concept of “invariant opératoire” and Science Education, when he refers to empirical research on the mental representations of pupils which he himself has carried out and to the relevant teaching proposals)! Also, in these works, we identify the idea of the decisive role played in the construction of knowledge by “each specific field of knowledge” ([56], p. 8), an idea which is further developed in other texts linked to the theoretical framework of the Piagetian studies, such as in [43] where Halbwachs stresses that “it is important to focus our attention on the particular significations of the notions that constitute the content of logical frameworks, and on the relations that organize these significations” ([43], p. 64). More specialized texts on the historical development and psychogenesis of specific concepts of Physics and their implications for teaching accompany the above general texts. These texts refer to concepts in mechanics ([59], [60], [61], [62], [64], [65], [66], [70]), temperature and heat ([55], [68]) and the gaseous state of matter ([54]). Halbwachs had also devoted some time to the study of *programmed learning and teaching*, a long-standing field of research, particularly active during periods of development of new technologies in the field of education, as was the case with the development of personal computers in the 1970s and 1980s ([49], [65]).

49. Halbwachs, F. (1974). Ordinateurs et enseignement. *Cahiers Pédagogiques*, 122, 18-21.
50. Halbwachs, F. (1975). La physique du maître entre la physique du physicien et la physique de l'élève. *Revue Française de Pédagogie*, 33, 19-29.
51. Halbwachs, F. (1975). Sur les finalités de l'enseignement des Sciences Physiques dans le premier cycle. *Bulletin Union Physiciens*, 577, 79-84.
52. Halbwachs, F. (1975). Les objectifs didactiques assignables à l'enseignement du second degré. *Actes du colloque AFCED (Association Française des Chercheurs en Didactique)*.
53. Chirouze, J.-P., & Halbwachs, F. (1977). Les finalités de l'enseignement en Sciences Physiques et technologiques dans le premier cycle. *Bulletin Union Physiciens*, 599, 367-372.
54. Groupe de recherche [D. Jearsain, J. Andréani, R. Martorano, F. Halbwachs, J. Chatil-

- Ion, J. Bayetti, G. Canova, P. Planche, G. Scotto] (1977). Introduction à l'enseignement de l'état gazeux en classe de sixième. *Bulletin Union Physiciens*, 599, 401-432.
55. Jearsain, D., Andréani, J., Halbwachs, F., & Martorano, R. (1978). Initiation à l'étude de la température et de la chaleur en classe de Cinquième. *Bulletin Union Physiciens*, 604, 1013-1035.
56. Vergnaud, G., Halbwachs, F., & Rouchier, A. (1978). Structure de la matière enseignée, histoire des sciences et développement conceptuel chez les élèves. *Revue Française de Pédagogie*, 45, 6-15.
57. Halbwachs, F. (1978). Structure de la matière enseignée et développement conceptuel. *Revue Française de Pédagogie*, 45, 33-36.
58. Halbwachs, F. (1979). Some applications of principles from developmental psychology to science education. *European Journal of Science Education*, 3(2), 169-171.
59. Halbwachs, F. (1979). Le poids et la masse : À propos des nouveaux programmes de sixième. *Bulletin Union Physiciens*, 613, 869-873.
60. Halbwachs, F., & Bovet, M. (1980). Le poids et la masse en classe de sixième. *Revue Française de Pédagogie*, 53, 4-18.
61. Groupe de Recherches sur l'Enseignement de la Physique (1980). Initiation à la mécanique en classe de quatrième. *Bulletin Union Physiciens*, 620, 485-503. [participation F. Halbwachs]
62. Halbwachs, F., & Bovet, M. (1983). Sur le poids et la masse, la Statique et la Dynamique. *Revue Française de Pédagogie*, 63, 110-127.
63. Halbwachs, F. (1983). Le centre interdisciplinaire en sciences de l'éducation de l'université de Provence. *Revue Française de Pédagogie*, 65, 111-113.
64. Champagne, A., Halbwachs, F., & Meheut, M. (1983). Workshop n° 12: Representations and their role in learning in the fields of Mechanics and transformations of matter. In *Research on Physics Education, Proceedings of the 1<sup>st</sup> International workshop* (pp. 629-634). Editions du CNRS.

## TEXTS RETRIEVED FROM THE HALBWACHS ARCHIVE

Some undocumented and/or unpublished files were found in the Halbwachs archive. Two of them, which belong to the third period of his research activity, we decided to publish in this special issue ([65], [68]). The remaining bibliographical references refer to texts related to the whole design of this special issue. However, the archive is larger in volume and includes texts and other documents of particular value for evaluating not only the conceptual content of his work but also the political, social and educational environment within which it was produced. Further exploitation of this rich archive is the responsibility of the historian of education.

65. Halbwachs, F. (1973). Genetic development of the concepts of Mechanics and application to teaching problems. Draft of a paper presented in the *International Conference on Science Adult Education* (London, 2-4 April) [In this issue].
66. Halbwachs, F. (1975 ?). *Initiation à la Mécanique en classe de quatrième*. Rapport d'expérimentation (typed).
67. Halbwachs, F. (1976). La conceptualisation en mathématique et en physique. Rapport présenté aux *Journées Nationales de l'Association des Professeurs de Mathématique*. Rennes, Septembre 1976 (typed).
68. Halbwachs, F. (1977). Some remarks on the psychological approach in Didactics. Draft of a paper presented at the *Workshop "Developmental Models of Thinking"* (Kiel, 11-14 September) [In this issue].
69. Halbwachs, F. (1978 ?) *Sur l'impact potentiel de la pensée de Piaget sur l'enseignement de la physique* (typed).
70. Halbwachs, F. (1980 ?) *Sur les représentations de la dynamique chez les élèves des collèges* (published ?).
71. Halbwachs, F. (1983) *Notions théoriques sur le problème didactique* (typed, mentioned in the *Proceedings of the 1<sup>st</sup> International workshop "Research on Physics Education"* [p. 633]).
72. Halbwachs, F. (a.d.) *Thèses préliminaires à une didactique de la physique en premier cycle de l'enseignement supérieur* (typed).
73. Halbwachs, F. (a.d.) *Marxisme et sciences physiques* (manuscrit ~ 200p.).
74. Halbwachs, F. (a.d.) *Existe-t-il une catégorie universelle de la contradiction ?* Exposé de F. Halbwachs et discussion de l'exposé (typed).

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