ASTRONOMY AND ASTROPHYSICS IN THE CURRICULA OF THE GERMAN GYMNASIUM

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1. Introduction

The school system in the Federal Republic of Germany is generally of the classical European type as defined by D. Wentzel in his paper for this colloquium. Children enter school at age 6. After 4 years of primary school they enter secondary schools. The gymnasium type lasts for 9 or 7 years, depending on the state. The final exam (Abitur) entitles the students to go to university.

The interest of pupils in learning about astronomy is generally very high. But the usual science or physics teacher's education in most of our federal states does not include any thorough knowledge of astronomy; physics curricula are overcrowded with traditional matter and more and more modern technical applications, without reducing the time allotted to old topics. Practically speaking, there are very few lessons left that might be used for astronomy teaching.

The current situation reflects the contents not only of the recent standard curricula but also of curricula for many decades in the past. Only during the last 10 years could a slight trend for the better be recognized. But the situation has worsened again, as it has been demanded that Computer Science become a new subject of rather high priority for schools.

Generally, in junior high school only rudimentary aspects of astronomy are included in the standard syllabi, namely: phases of the moon, eclipses, and some basic optics of telescopes in physics courses; seasons and time in geography courses. The discussion of concepts of energy supply may lead to including some more astronomy or astrophysics beyond only solar energy. There are only a few exceptional states in which an 8-to-12-lesson course of Space Science is included in the physics curriculum. Optional courses in an additional subject are possible in some states.

For senior high school, the situation is varied, because of different state regulations and organizational models. For students taking physics during grades 12 and 13, it depends on state, school, and teacher whether or not the student learns astronomy. In an elective physics course, astronomy may be included as a topic for one or two semesters (out of four). But none of the federal states has astronomy or astrophysics as a standard topic in the curriculum for physics majors.

2. Astronomy Curricula

Curricula are developed separately in every federal state. A first project was

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carried out in Baden-Württemberg in close cooperation with the Astronomische Gesellschaft during the early 1970s. The resulting curriculum led to the introduction of astronomy as an additional separate subject for senior high schools there. It can be chosen for grade 13, and it is rather popular with students. The curriculum (Table 1) has become a standard basis for curriculum development in some other federal states.

Table 1. Curriculum in Baden-Württemberg

I.	Apparent and True Motions in the Sky
	Daily and Yearly Motions
	Gravitation and Keplerian Laws
	Bodies of the Planetary System
	The Sun as a Star
	Solar Properties
	Internal Structure
	Solar Activity
II.	Properties and Physics of Stars
	Hertzsprung-Russell Diagram
	Color-Magnitude Diagram
	Stellar Evolution
	Properties of the Milky Way System
	Properties and Physics of Galaxies
	Cosmology

About the same time, a group from Bochum University used a different approach in developing a curriculum for North-Rhein-Westfalia. Their basic concept is to teach physics from an astronomical or astrophysical point of view (Table 2). Two semesters deal primarily with electric and magnetic fields and electrodynamics or atomic physics, respectively. Astrophysical aspects (like radioastronomy or stellar spectroscopy) are used here as applications of general physics only.

Table 2. Curriculum in North-Rhein-Westfalia

11/I	Kinematics of the Planetary System
11/II	Gravitation and Space Flight Physics
12/I	Analysis of Optical Stellar Radiation
	Hertzsprung-Russell Diagram
12/II	Electric and Magnetic Fields
	Radioastronomy
13/I	Atomic Models
	Radiation in Stellar Atmospheres and Space
13/II	Nuclear Processes in Stars

As an example for the curriculum of a one-semester course, I give the newly proposed syllabus of Hessen (Table 3). It will presumably become effective in 1989.

Table 3. Curriculum in Hessen (proposed)

The Planetary System
Motions on the Celestial Sphere
Gravitation, Keplerian Laws and Applications
Properties of Planetary System Bodies
The Stars
Distance and Brightness
Important Physical Properties
H-R Diagram and Stellar Evolution
Galaxies
Physics of the Milky Way System
Galaxies and Cosmology

3. Books

Members of the working group in Baden-Württemberg have published a matching two-volume textbook of rather high standard. It is one of four textbooks on the German market, intended for schools but of very different levels. The lack of adequate teaching material may be in some cases one more reason not to do astronomy at school, for the individual teacher will have to develop most of the material for his lessons on his own.

4. Teachers' Education

At the university, astronomy is almost completely absent in physics teachers' education. During employment, teachers can participate in continuation courses to keep up with the evolution of science and with didactics. Courses with astronomy or astrophysics as topics are also offered by the regional institutes responsible, and they are usually strongly overbooked. An "index" C, which shows the average number of astronomical courses per year for a federal state, is mostly $0.1 \leq C \leq 1$, but would be $C \approx 2$ if demand were followed. This lack underlines the low priority given to astronomy by state officials in education.

Fortunately the associations of professional and of amateur astronomers both usually dedicate part of their convention programs to teachers and school astronomy. Over a long time span, these conventions contribute remarkably to providing better information about astronomy to science teachers.

Discussion

M. Dworetesky: *Would you agree that syllabi and levels of the German gymnasium*

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courses are more or less comparable to North American university courses for physics students, and possibly at a level comparable to that of the UK introductory course described in my paper?

H. Neumann: As I'm not familiar with the US system, I rather would like to compare the German 13th (perhaps even 12th) grade to introductory college levels. Comparison must be checked from the details, as for the UK system. But the similarity with the UK system might be higher.

TEACHING ASTRONOMY AT KEIO SENIOR HIGH SCHOOL, JAPAN

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1. Introduction

The major problem in teaching astronomy in our senior high schools has to do with the nature of the Japanese educational system. The typical science curriculum consists of physics, chemistry, biology, earth science, and general science I & II. The Japanese Ministry of Education allows General Science I to fulfill the minimum high-school graduation requirement in science. General Science I covers the basics of earth science. Astronomy has been taught as a part of General Science I and Earth Science.

Table 1. The Japanese Ministry of Education's Current Educational Guideline

Subject Area	Subjects	Credits[a]	Statistics[b]
	Gen. Science I	4	Required Course
	Gen. Science II	2	Uncommon
Science	Physics	4	22%
	Chemistry	4	39%
	Biology	4	32%
	Earth Science	4	7%

[a]One credit = 35 classroom hours of lessons. One classroom hour = 50 minutes.
[b]From text sales.

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