PROBLEM OF INTERDISCIPLINARY INTEGRATION IN TEACHING ASTRONOMY

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Abstract: Astronomy problems are divided into four types of problems, just like physical problems. It is divided into qualitative problems, experimental problems, computational problems and graphic problems. In this article, the problems and solutions of the interdisciplinary integration problems and the shortcomings of the school educational programs in solving the problems of the astronomical problems in the school by the arithmetic method, the algebraic method, the geometric method and the graphic method are presented.
Keywords: astronomy, physics, mathematics, geometry, integration, method

Introduction. As we know, problem solving is of great importance in astronomy. Because by solving the problem, the student will, in some sense, have a wider penetration of the theoretical knowledge gained from a scientific and practical point of view. When solving a problem, the student fully understands the conditions of the problem and relies on the scientific and theoretical knowledge obtained from the sciences of physics, algebra and geometry. Also, astronomical problems should always be explained in connection with astronomical tables. Here, students will be able to use astronomical tables, star atlases and maps, and calendars. In this place, students learn that solving problems is related to mathematics and physics, as well as improving their worldview. But mathematical aspects of solving problems cause some difficulties for students. Because solving some astronomical problems is done on the basis of topics taught in higher mathematics, and because this problem is not covered in school mathematics textbooks, it causes students to lose their self-confidence.

Methods. The method of solving the problem is suitable for many conditions; it depends on its content, the students' preparation, the teacher's goal and the circumstances. However, for most problems, there are some general rules to consider when solving problems with students. In addition, there are some unique features in working with problems from astronomy. These are:

Qualitative questions: Qualitative questions are given primarily to reinforce the material studied. Solving qualitative problems usually consists of being able to make logical conclusions based on the laws of physics using induction and deduction methods.

Experimental problems: As we mentioned above, a characteristic feature of such problems is the use of a laboratory or demonstration experiment to solve them.

Calculation problems: Methods for solving calculation problems depend on their complexity, students' readiness, the teacher's goal, and many other factors.

Methods of solving problems are as follows:

Arithmetic method. In this method, only arithmetic operations are performed on physical quantities.

Algebraic method. In this method, students' knowledge of algebra is used, formulas are used, equations are created and solved. The easiest way to use the algebraic method is to use ready-made formulas to solve problems.

Geometric method. When solving problems with a geometric method, the sought quantity is found from the geometric relations known to the students. The geometric method is widely used in statics, geometric optics, electrostatics and other sections of the physics course. The method of geometric solving of problems is used not only by geometric relations, but also by trigonometric formulas.

Graphic method. The geometric method and the method of graphical problem solving are closely related. In the graphical method, the sought quantity is found using a graph. Due to the uniqueness of these issues, we will consider them separately.

Graphical problems. Problems whose object of study consists of graphs of connection of physical quantities are called graphical problems. In some cases, these graphs are given in the condition of the problem, and in some cases, you have to make them. The first graph consists of reading problem graphs and making simple graphs.

Results and Discussion. Current astronomy textbooks cover all sections of the general astronomy course. Among these topics, students have to use issues that are difficult for them to master. Below are two examples of these examples.

1. At a frequency of ~15GHz, the Green Bank Telescope can confidently detect flux densities down to around 0.2mJy. Below this, the telescope begins to run into its "confusion limit," where there are too many objects at the same flux density, such that no single object can be identified. What is the maximum distance we could detect thermal emission from a neutron star (T ~ 105 K, radius R ~ 10km) given this confusion limit? The nearest neutron star is 85pc away, and the most sensitive radio telescopes can detect down to around 1μJy. Comment: could humans ever detect thermal emission from neutron stars? Consider what astronomers might try to do to have a better chance at detecting thermal emission from a pulsar.

Answer: We know that for small angles the flux Sν = IνΩ = IνπR2/D2, where D is the distance to the star. Thus a star will be detected if

$$D \leq \sqrt{I_\nu \frac{\pi R^2}{S_{\lim}}}; I_\nu = B_\nu = \frac{2kT\nu^2}{c^2}$$

the latter we can use to consider thermal (blackbody) emission in the RJ approximation. Therefore to simplify...

$$D \leq \frac{\nu R}{c}\sqrt{\frac{2\pi kT}{S_{\lim}}}$$

So with GBT's 15GHz confusion limit converted to MKS units, Sν = 2×10−30 WHz−1 m2, we can plug these in and get

$$D \leq \frac{(1.5\times10^{10})(10^4)}{3\times10^8}\left(\frac{2\pi\times1.4\times10^{-23}\times10^5}{2\times10^{-30}}\right)^{1/2}$$

Which gives us D ≤ 3×10−5 parsecs ' 1012 m ' 7AU. So basically it would have to be in the solar system! We apparently have no pulsars in our solar system, and it seems we would have no chance at detecting even the nearest pulsar in the radio band (given and radio frequencies up to ~ 1THz). Fortunately, pulsars also emit non-
thermal emission, which allows us to detect them up to much greater distances. Going to much higher frequencies can help us (thermal emission from neutron stars has, for instance, been detected at optical/X-ray wavelengths). Note that at those frequencies the Planck relation, not the Rayleigh-Jeans limit as used above, applies. You could also use Wien's Law to determine the peak frequency/wavelength of the emission at this temperature, which is in the optical band.For some reason, it is considered almost indecent to teach such a kitchen of estimated calculations - and as a result, students waste a lot of time in vain.

2. We get a lot of information about radio sources based on measurements of the flux density as a function of frequency (the spectral energy distribution). Most of the discrete radio sources making up the "radio" background in ERA Figure 1.4 (shown above) have power-law spectra of the form

$S \propto \nu^\alpha$

where the exponent α is called the spectral index. In the Figure, the slope of the straight line that represents the radio source background is about +0.3. Estimate the mean spectral index α of the sources making up that radio background.
Answer: The axes of the figure are such that the "radio" line has a power-law spectrum:

$$\frac{d\log(\nu I_\nu)}{d\log(\nu)} = +0.3$$

where
$I_\nu \propto S \propto \nu^\alpha$
and
$\nu I_\nu \propto \nu \cdot \nu^\alpha$
$\log(\nu I_\nu) = (1 + \alpha)\log(\nu) + \text{const}$
And so...

$$\frac{d\log(\nu I_\nu)}{d\log(\nu)} = +0.3 = 1 + \alpha \quad \rightarrow \quad \alpha = -0.7$$

This is the mean spectral index of the sources; incidentally, and un-coincidentally, it is also the mean power-law spectrum of optically thin synchrotron emission.
Below are examples of problems that students of general education schools can work on without difficulty:
In class 7: For example, we convert 6 hours 31 minutes 27 seconds given in hours, minutes and seconds into hours and tenths of an hour.
In class 8: The height of Sirius (a of the big dog, d=-16°37``) at its highest culmination is 10°. Find the geographical extension of the observation point.
In class 9: Find the deviation of the zenith point at a latitude of 42°.
In class 10: Determine the longitude of a place where the time is $12^h43^m21^c$ when Greenwich time is $10^h17^m14^c$.
In class 11: The asteroid Vesta orbits the Sun once every 3.63 years. This asteroid is several times farther from the Sun than Earth.
Of course, in general, when working on such issues, mathematical specialists should pay attention to this problem in order to fully solve the problem of mutual integration between the sciences of mathematics and astronomy.
1-table

Classes	**Total hours**			**Physics**	**Algebra**	**Geometry**
	theoretical	**practical**	**observation**			
7	34	18		A matter of quality		Graphical problem
8	34	18		A matter of quality		Graphical problem
9	34	18		A matter of quality		Graphical problem
10	34	18	18	A matter of quality	Calculation problems	Graphical problem
11	34	18	18	Experimental problems	Calculation problems	Graphical problem
Total	**170**	**90**	**34**			

Conclusion. Increasing the general workload allocated to astronomy at school, firstly, increases the quality of education in providing students with the necessary knowledge of astronomy, and secondly, increases students' interest in astronomy.

In the development of astronomy textbooks at school and the regulation of astronomical issues, interdisciplinary mutual integration, the amount of loading and the types of training based on the above table 1 will cause a sharp increase in the quality of education.

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