demonstrate that this method could be useful for preparing metallic glasses and amorphous semiconductors.

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V. E. Antonov, I. T. Belash, and E. G. Ponyatovskiĭ. *Hydrides: investigations under high hydrogen pressures.* The study of high-pressure phases in metal-hydrogen systems began at the Institute of Solid State Physics of the USSR Academy of Sciences in the mid-1970s after the invention of a quite simple and effective method for compressing gaseous hydrogen to high pressures.[1] Application of the method[1] made it possible to achieve record high hydrogen pressures up to 90 kbar (the highest pressure achieved abroad equals 30 kbar), which, in particular, made it possible to obtain and study hydrides of all 3d metals and all 4d metals with the exception of ruthenium, as well as hydrides of different alloys based on these metals.

Metals of the 3d series and their alloys exhibit magnetic order, and the possibility of saturating these metals with hydrogen up to high concentrations has in its turn opened up the possibility of studying the effect of hydrogen on the magnetic ordering in d metals. At first we had to endure a quite prolonged stage of accumulation of primary experimental information on the composition, crystalline structure, and magnetic properties of hydrides, forming under high hydrogen pressures, based on different 3d metals and their alloys. After this stage was completed two important facts became clear. First, hydrides are formed on the basis of only the two simplest packings of the atoms of the metals—fcc or hcp. Second, the effect of hydrogen on the magnetic properties of a magnetic material can be very diverse depending on the type of magnetic material being hydrated. For example, antiferro- and paramagnetic materials can transform into ferromagnetic materials, the spontaneous magnetization of the ferromagnetic materials can increase, the Curie points can decrease, and vice versa both these quantities can decrease, increase, or change nonmonotonically, etc.

But, probably the most interesting fact is that all diverse effects can be systematically explained and described under one assumption: the magnetic properties of the metals and alloys studied change under hydrogenation as a result of the increase in the degree of filling of their d bands with electrons, and in addition the hydrogen must be regarded as the donor of a fractional number of electrons $\eta < 1$ electrons/H atom. We note that the idea of hydrogen as a donor of a fractional number of electrons to the d band of the metal-solvent agrees with the results of calculations of the band structures of nickel and palladium hydrides, carried out by other authors.

Study of the influence of hydrogen has also made it possible to clarify the factors responsible for some of the features on the concentration dependences of the magnetic properties of alloys of 3d metals without hydrogen, and the following situation has now been achieved: if the composition of the alloy (let it be multicomponent) based on iron, cobalt, or nickel is given, then it is possible to predict *a priori* its magnetic properties in the fcc or hcp modifications, and also the effect of the interstitial hydrogen on these properties.[2]

As regards the properties of the hydrides of 4d metals and their alloys, here the study of superconductivity is of greatest interest. We began with the study of hydrides of alloys of palladium with Cu, Ag, and Au, since previously, by means of implantation of hydrogen into these nonsuperconducting alloys, samples with a superconducting transition temperature T_c up to ≈ 17 K were obtained (see Ref. 3), while theoretical estimates of the values of T_c for Pd–Ag–H hydrides gave values of up to ≈ 50 K.[4] Our measurements on massive homogenous samples of hydrides obtained under high pressures, however, showed that these effects are not observed in Pd-noble metal-H systems, and, therefore, high values of T_c for hydrides with implanted hydrogen were determined specifically by the characteristics of the samples obtained precisely by this method.

This result made it necessary to analyze critically the existing information on the superconductivity of hydrides of d metals, and it turned out that the situation is not much different from the situation which existed at the starting stage of the study of magnetic properties of hydrides of 3d metals: correct data for massive single-phase samples are in fact limited by the fact that the superconducting properties of Pd hyrides have been studied in great detail, while superconductivity has not been observed in the hydrides of Ti, Zr, Hf, V, Nb, and Ta, and that there is no theory or even empirical recipes for further searching for superconducting hydrides.

To evaluate the role that a change in the degree of filling of the conduction band of the metal-solvent by electrons can play in the change in T_c accompanying hydrogenation we studied the influence of hydrogen on T_c of the bcc alloys Nb–Ti, which are convenient for this purpose, and for all alloys studied we observed a sharp (≈ 15 K/H atom) drop in T_c. This effect cannot be explained by a change in the electron density of the alloys and must necessarily be attributed to the change in their phonon spectrum. This implies that in the case of hydrogen solutions one can hardly depend on the predictions of the rigid-band model, satisfactorily describing the concentration dependences of T_c for alloys of d-metals without hydrogen, and in order to search deliberately for new superconducting hydrides other guideposts must be sought.

For such a quidepost we employed the published data on the fact that hydrogen-saturation of niobium alloys with

Ru, Rh, and Pd can increase the value of T_c of the samples (see Ref. 3). We studied the system Nb–Ru–H and two of its close analogs V–Ru–H and Ta–Ru–H, and amongst the phases forming in these systems under high pressures we discovered hydrides with values of T_c ranging from ~ 3 up to ~ 5 K, while for the starting alloys without hydrogen $T_c \ll 2$ K. This result suggests that if the data on the existence of superconducting hydrides in the systems Nb–Rh–H and Nb–Pd–H are confirmed and, as in the case of Nb–Ru–H, superconducting hydrides are also observed in the analog systems, then it will be possible to prepare and study in the near future an entire new group of diverse superconducting hydrides, thereby beginning the construction of the minimum necessary experimental base for subsequent analysis of the character and mechanism of the effect of hydrogen on the superconducting properties of d metals.

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A. A. Ruzmaĭkin. *Magnetic fields on the sun.* The sun is a laboratory of dimension $7 \cdot 10^{10}$ cm. Here astronomy, hydromechanics, plasma physics, and nuclear physics are intertwined. Thermonuclear fusion, Alfvén waves, the hydromagnetic dynamo, and new ideas about the neutrino are the products of scientific interest in the sun.

The equilibrium of the sun as a star is determined by the balance between the force of gravity and the pressure gradient. On the other hand, solar activity is the interplay of motions and magnetic fields. Magnetic fields are directly observed in active phenomena (in the spots, regions of flares, protuberances) or are linked with them (heating of the corona, coronal holes).

The flow of the solar plasma is a combination of large-scale motions (differential rotation, meridional circulation) and random motions (turbulent convection). The magnetic field in such a medium is a stochastic quantity. On small scales separate concentrations of the field, intensified at the boundaries of the convective cells (supergranules) stand out. Observations show that their scale is of the order of $(1-3) \cdot 10^7$ cm, and the field intensity is of the order of $(1-2) \cdot 10^3$ G. This is similar to the picture, characteristic for the transport of the magnetic field in a random medium, of intermittency,[1,2] modified by the expulsion of the field toward the boundaries of the convective cells.[3] The existence of a characteristic scale is indicated by the form of the correlation function of the fluctuation fields, calculated by N. I. Kliorin, D. D. Sokolov, and the author for the isotropic model of the dynamo.

There exists an average, large-scale magnetic field on the sun. Its axisymmetric poloidal component has an intensity of the order of 1 G and the main spatial mode is of the dipole type, oriented along the rotational axis. The field in the spots is interpreted as the manifestation of a subphotospheric toroidal magnetic field, whose lines are oppositely oriented in the northern and southern hemispheres of the sun. The intensity of this field can be estimated if the total magnetic flux of the spots and the relative fraction ε of the area of the sun's surface occupied by them over a definite period of time are known: $B_\varphi \sim \Phi/\varepsilon 4\pi R_\odot^2$. For example, for the period 1964–1974 $\Phi \approx 1.6 \cdot 10^{23}$ Mx, $\varepsilon \approx 5 \times 10^{-3}$ (these data were reported to the author by K. S. Tavastshern), which gives $B_\varphi \approx 6 \times 10^2$ G. Near the boundary of the convective shell with a radiant core, in a narrow layer of the order of $5 \cdot 10^5$ cm, this field can be intensified up to 10^7 G, owing to the effect of diamagnetic expulsion.

In addition, the sun has a weak nonaxisymmetric field (about 0.5 G), corresponding to the dipole and (or) quadrupole, whose axes lie in the plane of the solar equator (the so-called sectoral structure).

It has been hypothesized that strong fields exist in the solar core. However, fields with an intensity exceeding 10^7 G, whose lines penetrate up to the surface, would give a much too strong flux at the surface. Helioseismology could provide the decisive word with regard to such fields.

The sun's magnetic field does not remain constant. Small-scale fields vary in an irregular, random manner. The axisymmetric, sectoral component varies approximately with the rotational period of the sun around its axis. The 22-year cycle of the axisymmetric field is well known. In addition, one stronger branch of the field extends from latitudes of the order of 40° to the equator, and another weaker branch extends from these latitudes to the poles, which is well observed in observations of protuberances.[4] Every 11 years the dipole component reverses and the orientation of the toroidal field changes. Modulation with a characteristic time of approximately three periods and deep, irregular minima, observed by nuclear methods based on the content of the ^{14}C isotope in tree rings, are superposed on the 22 year cycle. The behavior of the activity near the Maunder minimum has also been studied at the Leningrad Physicotechnical Institute.[5]

The transport and intensification of the average magnetic field are determined primarily by turbulent diffusion, differential rotation $\Omega(r,\theta)$, and the average spirality of the turbulent convection. Neglecting diffusion, as Yoshimura first showed, the solution has the form of a dynamo wave propagating along the surfaces $\Omega = \text{const}$. Taking into account diffusion, geometric characteristics, and boundary conditions requires complicated computational experiments; see, for example, Ref. 6. In recent years, S. V. Star-