BROWN DWARFS' ATMOPSPHERES: POSSIBLE ANALOGY FOR CONDENSATION IN THE SOLAR NEBULA.

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Introduction: In the last years the great number of discovered brown dwarfs (BDs) made it useful to analyze the connection between their outer "atmospheric" characteristics and the known (or proposed) processes realized during the formation of the Solar System. In this abstract we summarize some interesting possible processes which could be present in BDs. Our model based on Solar System condensation models because the BDs' atmospheres, during their cooling, probably represent a p/T environment nearly similar to that had been realized in the solar nebula. Therefore similar condensation sequence can be expected there.

Working method: Our simple model uses the observed luminosity and evolutionary sequence of BDs and the condensation sequence in the early Solar System based on Lewis and Barshay's model (Fig. 1.) [1]. The connection of solar disc p/T and application of the LB model to extended stellar atmospheres by Bérczi and Lukács (Fig. 2.) [2] was used in this modelling for the condensation in a hypothetical Brown Dwarf environment. Because of the lack of accurate up to date model of the internal structure of BDs we used a simple approach.

The Solar System as an example: Our Solar System formed from a nebula via contraction, heating up, differentiation, and finally fusion in the core, crystallization on the stellar atmospheric periphery. Equilibrium condensation models of the Solar System (Larimer, l967; Grossman, l972; Barshay and Lewis, l974) [1], [3], [4] has deduced compositional belts with characteristical mineralogy around the forming Sun. The sequence of mineral belts were calculated in [3, 4] and was shown in [1] from the intersection of the main gas/crystal phase boundaries by the Cameron-type solar adiabat (Fig. 1.). These calculations were fitted to the planetary densities known today [1], and the place of appropriate mineral belts were estimated on the basis of the recently occupied orbital positions of the planets.

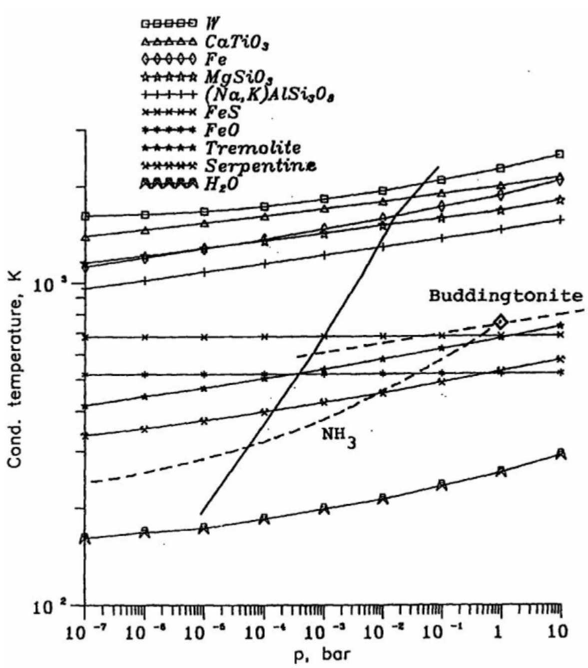


Fig 1

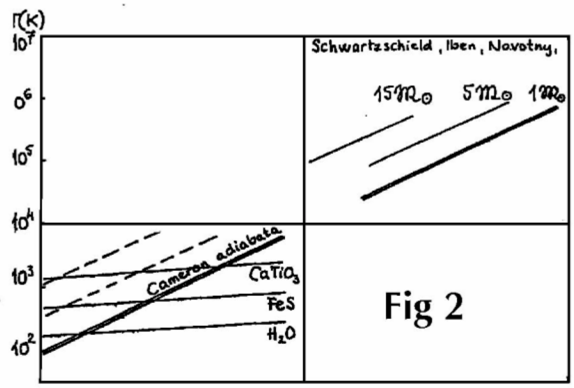
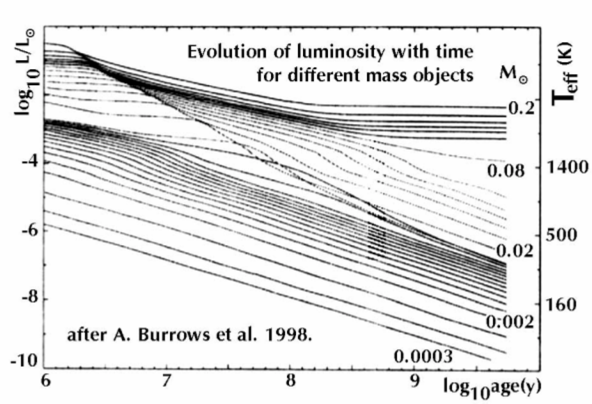


Fig 3



The condensation sequence of minerals: In the Barshay and Lewis (1975) [1] sequence of precipitation from the solar nebula (with cosmic elementary abundances, when temperature decreases according to the adiabat of Cameron, Fig. 1.) decreasing temperature differentiates the nebula. The temperature is the function of both solar distance and of time. Decreasing temperature with solar distance forms mineral belts around the Sun. Slow changes in the local tempera-

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ture result in time-dependent precipitation sequence in the belts, locally, too. The condensation temperatures and adiabata of some different mass stars are shown in Fig. 2.

In the protoluminosity track of a star of 1 solar mass during its early formation period an initial condensational sequence and the corresponding spatial arrangement of the mineral belts develops. In the second (or late) period low temperature mineral belts get closer to the Sun, so the mineral condensates of the late period could stratify onto the earlier ones, and the secondary condensational mineral belts moved inward, toward the central star [2]. In the third (or over-cooling) period the luminosity will go below the later final stage. During this time a thin layer of even cooler condensates could stratify onto the earlier ones. However, this layer will slowly evaporate during the final increasing luminosity of the star. The condensates of this third period could be retained only if the planetary accretion could collect them in time.

The case of the Brown Dwarfs: It is interesting to analyze a near similar condensation sequence in BDs. There are two possible regions for this: 1. the protoplanetary disc (it is not known yet that protoplanetary disc can or can't form around BDs), and 2. the cooling outer atmospheres of BDs. (It is probable that real cases transitional ones between this two regions at certain mass range of BDs.) Today there are just scattered observations in this field. We need relative cold BDs in this model, however the more cold a BD is, the more difficult is to discover it. One good example is Gliese 229B which atmospheric temperature is lower than 1000K [5]. Well our model is far from comlpete but have several basic assumptions already.

The model: *The "steady state" approach*: On Fig. 3. a p/T diagram is visible with boundaries of solid phases of some minerals [6]. The internal p/T curve of different mass objects from 0.115 M-sun to Jupiter is also visible [6]. In this static diagram it is obvious that in different depths inside the atmospheres different minerals rain out. The real condensation depends on how much is the layer depleted in certain compounds and how big is the convection supported feeding of that components. In an ideal case with no convection the depletion depends on the previous condensations in that layer. Based on the theoretical models and observations it is highly supported that there is convection.

The "lifting-convecting" approach: After the condensation of any matter the physical track of the droplets depends on the bouyant force and the convection of the surrounding gas. Based on the balance between them the nuclei can move upward into lower p/T environment which cause possible stratification of cooler condensates, or they can move downward into higher p/T environment which cause melting/evaporation/sublimation of them.

The time dependent approach: The most interesting aspects of this model is that the certain temperature regions sink during the BDs' evolution toward higher density regions. In this case the condensation of certain compounds happens more and more deep inside the atmosphere. This sequence is difficult to calculate because there are no accurate internal p/T models for BDs and for their evolution today. In [7] we find a calculated temperature/luminosity curve for objects with different mass, where a theoretical approximation of calculated effective temperature is given (Fig. 3.). It is not for to use for the condensation of certain materials (it depends on the local pressure and these values are only approximations of the true photospheric temperatures) but graphs show the cooling tendency. As an analogy the temperature decrease in BDs is similar to that of in the Solar Nebulae, but at different stellar distances. The greatest difference is in the increasing pressure near the BDs. In the Solar Nebulae model the pressure variation could be far smaller, so the position of the condensation of a mineral belt in the p/T diagram sinks to lower temperatures. In the BDs a hypothetic atmospheric point is cooler compared to the corresponding solar distance and at this point the pressure is different, too.

Discussion: Based on the recent observations of BDs and the models of the condensation in the Solar Nebulae during the cooling of BDs a condensation sequence occurs in their outer atmospheres. Lewis-Barshay type compounds condensate in a corresponding p/T region (one below each other) which slowly sink, getting nearer and nearer to the stellar surface and possible below it during the life of a BD. The thickness of a region depends mainly on the convection and surface gravity. During their evolution BDs are contracting more and more slowly toward a Jupiter sized object, and this contarction affects the vertical pressure distribution. The higher gravity in the vicinity of the BDs "surface" causes far smaller scale height in their barometric height formula than that for example is in the atmosphere of Jupiter.

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