Simple math model for calculation about possibility to disclose Stealth

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Abstract. Stealth coating is the antidote against of the radar. But it can be disclosed by the microwave radiometer because their job based on the measuring the radio-brightness contrast between Stealth object and the background of the environments (sky is cold, Earth is warm). This short report presents some math model for the simplest calculation of the possible disclosing distance till the Stealth object.

1. Introduction
No big reason to talk much about super big interest to safety of the modern military devices against of the radar disclosing. Various super modern microwave radar systems overcome the barrier of inaccessibility for to find customer on the international market of the armament. Modern military ships (figure 1) have the special form of their surfaces for to do the reduction of the radar cross-section (RCS).

Figure 1. Military ships made with using Stealth technology (from the INTERNET).

Anti-air systems are on hearing of the international news. Which system is better, more effective and have got real success in the corresponding actions. As about military aircrafts (figure 2) in current world market exists super competition concerning their technical parameters. First it is imperceptibility, for the radar, optical and the infrared (IR) disclosing systems. Naturally, super new modern military systems and aircrafts is condition and the base for super big money, corresponding profit and the chance to receive the leadership on the international military market.

In this place after several interesting pictures from INTERNET it will be reasonable to input some
simple explanation about corresponding microwave radiometry [1-2].

Firstly, it was big hope to design and to produce the various passive millimeter wave imaging system (PMWIS) as the fourth type of the remote disclosing systems in addition to the existing optical, radar and IR systems. For the real understanding the situation in this special fields, it is interesting to read old publications and patents concerning military designs and applications [3-8] based on using millimeter wave bands published during time of the Cold War. Why there are millimeter wave bands: first reason is possible sizes of the real antennas, because the job of the radiometric system based on the kwazi-optical principles. Secondary- the great successes of the semiconductor technology Monolithic Microwave Integrated Circuits (MMIC) carry out big impulse for the design of the direct amplifier receivers. It were the base for the creation of the matrix PMWIS without the heterodyne receivers and complicated bulky systems with special local oscillator for to overcome the electromagnetic compatibility [2].

![Figure 2](image.jpg)

**Figure 2.** Military aircrafts made with using Stealth technology (from the INTERNET).

Third: a lot of modern microwave companies after estimation the huge potential growing market of PMWIS for airport’s security control for the detection of concealed objects under clothing have got big investment. Based on the growing problems of the terrorism, especially after 11 September 2001, increasing budget programs has been adopted in rich countries to design special PMWIS [9]. So, in this introduction part, there is no reason to detail the function of microwave radiometry and it is reasonable to attract main attention to simple practical technical details about possibility to discover the remote Stealth ship or aircraft with the help of the radiometric devices.

2. **Simple math model for possible calculation**

For the simple explanation about radiometry let us see the figure 3 where, for example, the radiometer...
For the explanation about the radiobrightness contrast, is installed on the airplane and will examine two following measurements by radiometer. In the first spot of the antenna beam on the earth surface there absent some metal object and such object (as a car) exists in the second one. For the measuring such radiation from the different spots (objects) it will be more correct and understandable to use, so named, expression as the radio brightness temperatures of the objects which can be expressed in temperature’s unit \( T \). It can be done the simplest calculation, concerning the microwave power \( P = kT\Delta\nu \), where \( k \) –Boltzmann’s constant, \( T \) – brightness temperature, \( \Delta\nu \) - the band of the receiving frequencies, which income to the radiometer from this two antenna’s spots as the answer - which sensitivity of radiometer is necessary for the finding the real distinction between this two spots. Naturally this task had and has the real interest for the special aims and real tasks [3-8,10-12], and according to this it is reasonable to understand that this is special question in field of the critical technologies and were developed very well.

It is understandable that if the sensitivity of the radiometer will be better than the value of the corresponding result in formula on figure 3, the disclosing system will receive the need information about the presence of the metal object. On figure 3, this metal object with radio-brightness temperature \( T_{\text{sky}} \) is the roof of automobile, which reflect the sky radiation.

But if there exists task to find Stealth object it will be necessary to talk about the brightness temperature of the corresponding Stealth. But \( T_{\text{back}} \) - will stay the brightness temperature of the background of the environments: sky is cold; Earth, water (it has polarization peculiarities) is more warm.

The destiny of the Stealth is to be as antidote against of the radar. Reasonable to separate this antidote on the possible technical decisions how to remove the reflection/s from the Stealth to the receiver of the active radar.

1) First one – by using special surfaces which reflect radar radiation to the space or down on the earth surface for an absorption (radiated signal is going “in milk”), but not to the direction (or near for the multy antennas system) of the arrived radar sounding radiation.

2) Second one – using special absorption coating/s on the surfaces and places which is impossible or very difficult to exclude from the reflection of the radar radiation. Absorption in this case means – sounding radar power will be absorb by the material/s of such coating. On microwave language such
coatings must have the property of the black body or has name the matched loading. It must have Standing Wave Ratio (Voltage SWR -VSWR) near one unit. Various technologies about Stealth coating production in plenty has place in Internet and materials of the various corresponding conferences.

3) **Third one-** it concerns modern physical attainment as the plasma protection against microwave reflection. In this case the cloud of ionized gas at the principal surfaces will not transfer microwave radiation and will absorb it. But up to this time it is enough exotic [13].

Special surfaces 1) reflect radar radiation “in milk”, but such surfaces can promote and to be convenient for the remote radiometric detection, because nature produces radiations, which re-reflect from the various surfaces to antenna of the radiometer from the appropriated directions of the sky sphere or the earth with power depending on their radio-brightness temperatures [1].

As concern 2) in case of the full absorption we must remember about standard information during flight by civilian airplane - “temperature outside of the board is minus 56 by Celcium”. So, it is temperature of the disclosing blackbody which has name Stealth. Naturally the nature temperature difference in formula on figure 2 will have the enough real value for the disclosing.

The technical parameters of the radiometric system in formula on figure 3 are $S_{\text{back}}$ and $S_{r}$. Value of $S_{\text{back}}$ can be impressed as square of spot by antenna beam at the distance L and $S_{r}$ is possible square of the target at the same distance. Various details about current systems possible to find in a lot of corresponding publications [2,11]. Later it will be possible to do the arithmetical calculation for the simple evaluation the disclosing distance till Stealth. Naturally for the concrete math calculation as the model presentation it must be used standard “antenna-radar-microwave” additions as antenna efficiency, factor of the object position, the probability of the detection and others.

Such concrete calculation was not the aim of this short report.

But in this short report for the case of the realization some experimental evaluation it will be reasonable to represent some principal useful technical moments [10-12] without details.

### 3. Some useful technical details

Simple technical decision of the entrance part of the radiometric receiver can be done in form of some kind of zero-detector [10], which can be named as the discriminator. Block scheme of this and corresponding pictures, for an explanation, presented on figure 4. The work of discriminator based on next: two feeders combined with the one antenna and contr-reflector forms two space beams, each of them see its 50 % of the antenna surface directed on the two neighbour’s angles of the space. The angle dividing depends on the technical specification. Signals from feeders after switcher (the reflecting modulator and circulator) are going to the radiometer for the measuring. After measuring it is possible to decide about presence of the disclosing object, because the need result will arise only during the observing of the real different scenes.

### 4. Acknowledgments

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