

Diffusion processes with generators of generalized divergence form

By

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§ 0. Introduction.

In this paper we shall discuss a certain class of diffusion processes with singular coefficients. Our class contains the class of divergence form. Hence we call it generalized divergence form (G.D.F. in abbreviation).

G.D.F. have some applications to problems arising from fluid mechanics. Indeed, the Burgers process ([12]) and the vortex process are of generalized divergence form. Especially the vortex process is an example of generalized divergence form which is not of divergence form ([3], [11], [13]). Since the coefficients of these diffusion processes are singular, the construction is not easy. Our results are useful to construct such diffusion processes and also applicable for a homogenization problem ([8], [9]).

A differentiable operator $A = \sum_{i,j=1}^n \nabla_i a_{ij} \nabla_j$, $\nabla_i = \frac{\partial}{\partial x_i}$, is said to be a divergence form if $a_{ij}(t, x)$ are measurable functions satisfying

$$(0.1) \quad \lambda^{-1} |\xi|^2 \leq \sum_{i,j=1}^n a_{ij} \xi_i \xi_j, \quad \xi = (\xi_i)$$
$$|a_{ij}| \leq \mu.$$

Fundamental solutions of parabolic equations in a divergence form have been researched by many mathematicians. Especially important theoretical improvements were done by Nash [7] and Moser [6]. The most remarkable result was obtained by Aronson [1]. He showed the following estimate: Let $p(s, x, t, y)$ be a fundamental solution of $\nabla_t - A$. Then

$$(0.2) \quad C_1 t^{-n/2} \exp[-C_1 |x-y|^2/(t-s)] \leq p(s, x, t, y)$$
$$\leq C_2 t^{-n/2} \exp[-C_2 |x-y|^2/(t-s)]$$

for all $0 < t-s < \infty$, $x, y \in R^n$, where C_1, \dots, C_2 are positive constants depending only on λ, μ and n . It is one of our main purpose to show that (0.2) is also valid in the case of G.D.F..

Now we introduce a notion of generalized divergence form. Let $a_{ij}(t, x)$, $c_{ij}(t, x)$ ($i, j=1, 2, \dots, n$) be measurable functions defined on $[0, \infty) \times R^n$ and

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