5. AC Gas-Discharge Systems: Experiment

(references refer to the list of publications given in chapter 12)

A. Quasi 1-dimensional ac systems

A. 5.1 General remarks

Patterns of interest show up in the gas space in particular via the luminescence radiation density of the quasi 1-dimensional ac device fig. 5.1. This device is similar to the device fig. 4.1 of the chapter DC Gas-Discharge Systems: Experiment. We note that as in certain semiconductor devices strictly speaking ac driven systems cannot exhibit stationary patterns. Nevertheless, also in these systems we use the notion of “stationary patterns” provided the local amplitudes and phases of relevant variables are constant in time. With respect to the voltage source it is assumed that the latter is ideal in the sense that a constant amplitude and phase is applied to the electrodes of the discharge device, irrespective of the generated patterns. As a result in most cases we may consider localized structures
(LSs) originating from solitary filaments as dissipative solitons (DSs). Whether this assumption is justified in concrete experimental situations has not been investigated in detail so far.

A quantitative gas discharge specific modelling of the devices of the kind fig. 5.1 is based on a set of drift diffusion equations being accompanied by the Poisson equation (see equations (1-3) of the chapter Gas-Discharge: Theory. In addition it is interesting to note that qualitatively patterns showing up in ac driven systems are very similar to what is reported for dc systems in DC Gas-Discharge Systems: Experiment. Therefore it is tentative to speculate whether or not the 3-component reaction-diffusion equations (1-3) reported in the chapters A Model for Pattern Formation and Reaction-Diffusion Equations are relevant for ac systems too.
A. 5.2 Graphical representation of selected results

The following figures reflect main results that have been obtained experimentally for the quasi 1-dimensional ac gas-discharge systems fig. 5.1.

Fig. 5.2

Experimentally observed solitary filaments in the gas-discharge system fig. 5.1. The record is made with a streak camera in the space-time (abscissa-ordinate) plot. Bright areas denote high luminescence radiation density in the discharge space (gas) of fig. 5.1. One observes stationary filaments, filaments undergoing displacement in the course of time as well as generation and annihilation. [Pu015] - compare to: experiment e.g. figs. 47, 4.8, 4.22, 4.23, 5.13; theory e.g. 6.1, 6.2, 9.6, 9.22, 9.23
A 5.3 Listing of main results

With respect to the abbreviations used in the following listing of observed phenomena we refer to the Introduction.

Pu015: Willebrand, Niedernostheide, Ammelt, Dohmen, Purwins (1991)
isolated stationary and travelling fs
   exp: 1d-ac-GDS - stat fs; trav fs
splitting of fs
   exp: 1d-ac-GDS - in the course of time and in the presence of an
     ensemble of almost equidistant fs: irregular splitting of a single f
     and subsequent disappearance of the additional f by merging
generation, annihilation of fs
   exp: 1d-ac-GDS - in the course of time and in the presence of an
     ensemble of almost equidistant fs: merging of 2 neighbouring fs
     to 1 f followed by gen due to splitting; various other gen and
     anni processes occurring spontaneously or in the course of
     interaction
periodic pattern in $\mathbb{R}^1$
   exp: 1d-ac-GDS - drifting pattern consisting of fs
many f systems
   exp: 1d-ac-GDS - drifting pattern consisting of fs
bifurcation of fs including snaking
   exp: 1d-ac-GDS - snaking
experimental detection of complex splitting dynamics in quasi 1-
dimensional ac gas-discharge systems and related generation and
annihilation of solitary filaments and related DSs

Pu023: Willebrand, Niedernostheide, Dohmen, Purwins (1993)
summary - material also contained in Pu015

Pu078: Purwins, Astrov, Brauer (2001)
summary - experimental observation of solitary filaments and related
DSs based patterns and other patterns in quasi 1-dimensional planargas-
discharge systems observed in previous work

Pu083: Purwins, Astrov, Brauer, Bode (2001)
summary - experimental observation of solitary filaments and related
DSs based static and dynamic patterns in quasi 1-dimensional planargas-
discharge systems observed in previous work - comparison of the
experimental results with solutions of the 2- and 3-component reaction-
diffusion model - see also: Reaction-Diffusion Equations
B. Quasi 2-dimensional ac systems

B. 5.1 General remarks

Patterns of interest show up in the gas space of the quasi 2-dimensional ac device fig. 5.3 via the luminescence radiation generally being proportional to the current density. In contrast to the quasi 1-dimensional device fig. 5.1, as a rule the emitted radiation is observed through the transparent electrode. In this way, in the camera e.g. bright (dark) solitary filaments (fs) generate bright spots on a stationary dark (bright) background. For modelling of the system fig. 5.3 and remarks concerning the interpretation of the observed solitary filaments and related localized structures (LSs) as dissipative solitons (DSs) we refer to the remarks made in relation to fig. 5.1.

Fig. 5.3

Patterns of interest show up in the gas space of the quasi 2-dimensional ac device fig. 5.3 via the luminescence radiation generally being proportional to the current density. In contrast to the quasi 1-dimensional device fig. 5.1, as a rule the emitted radiation is observed through the transparent electrode. In this way, in the camera e.g. bright (dark) solitary filaments (fs) generate bright spots on a stationary dark (bright) background. For modelling of the system fig. 5.3 and remarks concerning the interpretation of the observed solitary filaments and related localized structures (LSs) as dissipative solitons (DSs) we refer to the remarks made in relation to fig. 5.1.
B. 5.2 Graphical representation of selected results

The following is a series of figures reflecting main results that have been obtained experimentally in relation to the investigation of quasi 2-dimensional dc gas-discharge systems fig. 5.3.

Fig. 5.4a,b

Experimentally observed periodic stripes in the quasi 2-dimensional ac gas-discharge system fig. 5.3 and the bifurcation from a stationary homogeneous state (not displayed) to a periodic stripe pattern (a). The bifurcation behaviour is represented in (b) and resembles a supercritical Turing bifurcation with the amplitude $\hat{U}$ of the driver as bifurcation parameter. [I. Brauer, “Experimentelle und numerische Untersuchungen zur Strukturbildung in dielektrischen Barrierentladungen”, Thesis, University of Münster (2000)] - compare to: experiment e.g. figs. 3.10, 4.2, 4.3, 4.11; theory 9.9 - see also [Pu028]
Fig. 5.5
Experimentally observed hexagonal pattern in the quasi 2-dimensional ac gas-discharge system fig. 5.3. The pattern may rotate, may have “point defects” and can exhibit “grain boundaries”. [I. Brauer, Thesis (2000)] - compare to: experiment e.g. figs. 4.13, 4.24, 5.15; theory 9.9 - see also [Pu015, Pu058; Pu067; Pu069; Pu112]

Fig. 5.6a,b
Snapshots of an experimental self-organized rotating and outrunning spiral pattern (a) and an outrunning target pattern (b) in the quasi 2-dimensional ac gas-discharge system fig. 5.3. [I. Brauer, Thesis (2000)] - compare to: experiment e.g. figs. 4.14; theory 9.9 - see also [Pu104]
Experimentally observed increase and decrease of the number of filaments in the quasi 2-dimensional ac gas-discharge system fig. 5.3. When first increasing and then decreasing the amplitude $\hat{U}$ of the driving voltage the cycle in the upper part of the figure is followed, with the generation of the corresponding patterns (a) to (d). [Purwins, Amiranascvili, Bödeker, to be published 2009] - compare to: experiment figs. 3.12, 4.5, 4.6, 4.16, 5.18, 7.3, 7.10; theory figs. 3.12, 9.6, 9.10 - see also [Pu046; I. Brauer, Thesis (2000); Pu125; Pu128; Pu129]
Experimentally observed isolated solitary filaments in the quasi 2-dimensional ac gas-discharge system fig. 5.3: Depending on the chosen parameters filaments with non-oscillatory (a, b) and with oscillatory tails (c, d) are observed. In particular the latter give rise to interesting interaction phenomena. [I. Brauer, Thesis (2000)] - compare to: experiment figs. 3.14, 4.19, 4.20, 4.21, 5.12; theory 9.3, 9.11, 9.12, 9.18, 9.19, 9.20, 9.30 - see also [Pu069]
Experimentally observed subcritical bifurcation from a stationary to a travelling filament in the quasi 2-dimensional ac gas-discharge system fig. 5.3. (A) depicts typical trajectories of filaments with vanishing (a) and non-vanishing deterministic (intrinsic) speed $v_0$ (b). The deterministic speed of the filament has been evaluated from noisy trajectories of individual filaments by using the new stochastic data analysis method developed in [Pu098, and Pu099]. The bifurcation diagram is displayed in (B) with amplitude $\hat{U}$ of the driving ac voltage as bifurcation parameter. [Pu117] - compare to: experiment fig. 4.18; theory figs. 9.1, 9.13, 9.14, 9.21
Experimental observation of the temporal evolution of a rotating breathing solitary filament in the quasi 2-dimensional ac gas-discharge system fig. 5.3. [Pu066] - also rotating dumbbell shaped filaments are observed- see also [I. Brauer, Thesis (2000)]
Experimental observation of travelling pairs of solitary filament in the quasi 2-dimensional ac gas-discharge system fig. 5.3. Time series of snapshots for two travelling pairs of filaments (a) and a single snapshots for four travelling pairs of filaments and a single stationary filament being positioned in the centre of the domain (b). The propagation is related to a new mechanism that is related to the mutual interaction of the two filaments forming a pair. [Pu074]
Experimentally observed clusters of solitary filaments in the quasi 2-dimensional ac gas-discharge system fig. 5.3: Filaments form well defined “molecules” with different symmetries at given voltage. From (a) to (e) the amplitude $\hat{U}$ of the driver is increased. [Pu028] - compare to: experiment figs. 3.14, 4.19, 4.20, 4.21, 5.8; theory 9.3, 9.12, 9.18, 9.19, 9.20, 9.30 - see also [Pu046; E. Ammelt, “Untersuchungen zur Strukturbildung in planaren Gasentladungssystemen mit bildverarbeitenden Methoden”, Thesis, University of Münster (1995); Pu058]
Experimentally observed generation and annihilation of a filament in the quasi 2-dimensional ac gas-discharge system fig. 5.3: In the course of time filaments are generated (a) and annihilated (b) at the positions marked by arrows. [I. Brauer, Thesis (2000)] - compare to: experiment figs. 4.7, 4.22, 4.23; theory 9.22, 9.23, 9.31, 9.34
Experimentally observed simultaneous existence of stationary solitary filaments with filaments travelling in a closed loop in the quasi 2-dimensional ac gas-discharge system fig. 5.3. Long (a) and short exposure time (b). (a) is magnified with respect to (b). The superposition of the four pictures in (b) generate the picture (a) too good approximation. [Pu028]
Experimental snap-shots of dynamic many filament patterns in the quasi 2-dimensional ac gas-discharge system fig. 5.3 [Pu131]. (a) Typical rotating hexagonal pattern with “point-defects” [see also Pu112]. (b) Travelling hexagonal pattern with a “grain boundary” [see also I. Brauer, Thesis (2000); Pu058]; (c) Superlattice with hexagonal symmetry [see also I. Brauer, Thesis (2000)]; (d) Pattern consisting of domains made of solitary filaments [see also Pu69]; (e) Pattern in the form of dynamical clusters (“molecular gas”) [see also I. Brauer, Thesis (2000)]; (f, g) continuous generation of filaments at the boundary and annihilation while travelling to the centre with relatively short (f) and long (g) exposure time [see also I. Brauer, Thesis (2000); Pu067]; (h) Filaments travelling on concentric rings with constant angular velocity while neighbouring rings may or may not rotate in opposite direction [see also Pu028]. - compare to: experiment figs. 4.26, 5.7, 5.16, 7.10; theory 9.35, 9.36 - see also [Pu015; Pu067]
Fig. 5.16a,b

Additional experimentally observed patterns consisting of solitary filaments in the quasi 2-dimensional ac gas-discharge system fig. 5.3.: chains (a) [Pu046] and rings [Pu117] (b) - compare to: experiment figs. 4.26

Fig. 5.17a,b

Experimentally observed single solitary filaments in the quasi 2-dimensional ac gas-discharge system fig. 5.3. In the course of time the pattern switches to different symmetries in an irregular manner: shape of the filament (a) and correspond integral luminescence radiation $\Phi$ as a function of time (b). [I. Brauer, Thesis (2000)]
Experimentally observed bifurcation cascade to bright filaments, intermediate patterns and dark filaments (a-h) in (A) and the reverse scenario (a-h) in (B) when increasing and decreasing the frequency of the driver of the quasi 2-dimensional ac gas-discharge system fig. 5.3. The evolution of the peak to background brightness clearly reveals the strong hysteresis when increasing ((a) of (C)) and decreasing the frequency ((b) of (C)). [Pu128] - compare to: experiment figs. 3.12, 4.5, 4.6, 4.16, 5.7, 7.3, 7.10; theory figs. 3.12, 9.6, 9.10

An interesting experimental kind of evolution to a hexagon-like arrangement of filaments being susceptible to a quantitative theoretical description is displayed in fig. 6.4 of the chapter Gas-Discharge: Theory. - Patterns being related to the generation of Voronoi diagrams are presented in fig. 10.5 of the chapter Applications.
B 5.3 Listing of main results

With respect to the abbreviations used in the following listing of observed phenomena we refer to the Introduction.

Pu015: Willebrand, Niedernostheide, Ammelt, Dohmen, Purwins (1991)
many f systems
exp: 2d-ac-GDS - for circular boundary geometry: stat, almost
hexagonal pattern consisting of fs; for quadratic boundary
geometry: stat, almost cubic pattern consisting of fs
together with [E. Ammelt, “Untersuchungen zur Strukturbildung in
planaren Gasentladungssystemen mit bildverarbeitenden Methoden”,
Thesis, University of Münster (1995)], this is the starting point for the
unique observation of a large variety of pattern in quasi 2-dimensional dc
gas-discharge systems.

Pu023: Willebrand, Niedernostheide, Dohmen, Purwins (1993)
summary - material also contained in [Pu015]

Pu028: Ammelt, Schweng, Purwins (1993)
isolated stationary and travelling fs
exp: 2d-ac-GDS - stat, trav fs; closed trajectories each being
occupied by several unidirectionally trav fs; coexistence of
isolated stat fs with the former closed trajectories
interaction of fs: repulsion
exp: 2d-ac-GDS - repulsion of fs for most parameter sets
interaction of fs: formation of molecules
exp: 2d-ac-GDS - in a relatively small parameter range: stat or slowly
drifting n-fs (n = 2, 3, 4, ...), number increases with
increasing driving voltage
many body f systems
exp: 2d-ac-GDS - stat hex pattern consisting of fs; fs
equidistantly arranged on rot concentric rings, fs on adjacent
rings may rotate in opposite direction
stripes in \( \mathbb{R}^2 \)
exp: 2d-ac-GDS - stat periodic stripes
fronts
exp: 2d-ac-GDS - stat fronts
bifurcation: snaking, Turing
exp: 2d-ac-GDS - snaking
exp: 2d-ac-GDS - bif: (stat hom) ↔ (stat stripes) supercritical
within experimental accuracy
first observation of “molecules” in 2-dimensional gas-discharge systems - solitary filaments and related DSs rotating on closed loops - many solitary filament and related DSs systems: equidistantly arranged on rotating concentric rings with adjacent rings that may rotate in opposite direction

isolated stationary and travelling fs
exp: 2d-ac-GDS - isolated stat, trav fs
interaction of fs: formation of molecules
exp: 2d-ac-GDS - stat, trav n-fs (n>1)
many body f systems
exp: 2d-ac-GDS - many stat, trav fs with little correlation; chains made of fs
fronts
exp: 2d-ac-GDS - trav fronts
bifurcation: snaking
exp: 2d-ac-GDS - snaking
summary of some results on quasi 2-dimensional ac gas-discharge systems and discussion of relation to the 2-component reaction-diffusion system - see also: Reaction-Diffusion Equations

Pu058: Müller, Ammelt, Purwins (1997)
isolated stationary and travelling fs
exp: 2d-ac-GDS - stat, trav fs, coexistence of the former two
interaction of fs: scattering and reflection
exp: 2d-ac-GDS - ref at boundary; mutual repulsion
interaction of fs: formation of molecules
exp: 2d-ac-GDS - stat n-f (n>1), coexistence of n-f with different number and symmetry, corresponding multistability
generation, annihilation of fs: due to collision
exp: 2d-ac-GDS - anni: two trav fs collide, one trav f is left; gen at boundary and an at grain boundaries
hexagons in R²
exp: 2d-ac-GDS - hex pattern due to mutual repulsion of fs; “grain boundaries”
many body f systems
exp: 2d-ac-GDS - hex pattern, with and without “grain boundaries”; simultaneous existence of a hex pattern with incorporated stripes consisting of relatively fast synchronously trav fs
bifurcation of fs: snaking
exp: 2d-ac-GDS - indication of snaking
experimental detection of various defect structures in periodic hexagonal solitary filament and related DSs based patterns in quasi 2-dimensional ac gas-discharge systems - detection of reflection, scattering, generation and annihilation of DSs

Pu066: Müller, Ammelt, Purwins (1999)
isolated stationary fs
exp: 2d-ac-GDS - stat fs
isolated breathing fs
exp: 2d-ac-GDS - breath fs: periodic change between a spherical
shape (with relatively low integral intensity) and a dumbbell shape (with relatively high integral intensity); non-rotating and rotating fs of the latter type rotating around the axis vertical to the main symmetry axis

**bifurcation of fs: breathing**

exp: 2d-ac-GDS - (stat spherical shaped f) ↔ (breath f)

**experimental discovery of a breathing solitary filament and related DS in the quasi 2-dimensional gas-dischargesystem**

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**Pu067:** Müller, Punset, Ammelt, Purwins, Boeuf (1999)

isolated stationary and travelling DSs

exp: 2d-ac-GDS - stat, trav fs

many fs systems

exp: 2d-ac-GDS - hex pattern; hex pattern with “grain boundaries”; simultaneous existence of a hex pattern with incorporated stripes consisting of relatively fast synchronously trav fs; hex domains separated by hom background areas

theo: 2d-ac-GDS, using a gas-discharge specific drift-diffusion model in \( \mathbb{R}^2 \) (one coordinate vertical to the electrodes and one parallel) with parameters taken from experiment - period pattern in the direction parallel to the electrode consisting of solitary fs (DSs), correct order of magnitude for the diameteter and distance of filaments

**first qualitative theoretical reproduction of the experimentally observed filamentary pattern and related DS pattern using a straight forword drift-diffusion approximation** - see also: Gas-Discharge: Theory

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**Pu069:** Brauer, Ammelt, Purwins (1999)

isolated stationary and travelling fs

exp: 2d-ac-GDS - stat, trav fs

**annihilation of fs: due to interaction**

exp: 2d-ac-GDS - collision of 2 fs with one being left

many body LS- (DS-)systems

exp: 2d-ac-GDS - hex pattern; double breakdown: hexdomains consisting of fs and corresponding to the first breakdown are separated by hom areas with low luminescence radiation density corresponding to a second breakdown within one half-period

**double breakdown within one half-period leads to two different patterns: a stationary homogeneous one and a hexagonal pattern consisting of solitary filaments and related DSs**

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**Pu074:** Brauer, Bode, Ammelt, Purwins (1999)

isolated stationary and travelling fs

exp: 2d-ac-GDS - stat, trav f

**interaction of DSs: formation of molecules**

exp: 2d-ac-GDS - one or several trav 2-f propagating on a circle near to the circular boundary; simultaneous existence of a stat fs with one or several trav 2-fs

**first experimental proof for a travelling molecule of which the propagation is due to mutual interaction of the solitary filaments and related DSs that the molecule is made of**
Pu078: Purwins, Astrov, Brauer (2001)  
summary - experimental observation of solitary filaments and related DSs as well as other patterns in planar gas-discharge systems

Pu083: Purwins, Astrov, Brauer, Bode (2001)  
summary - experimental observation of solitary filaments and related DSs as well as patterns made of such objects - comparison of the experimental results with solutions of the 2- and 3-component reaction-diffusion model

experimental detection of self-organized Voronoi diagrams in a quasi 2-dimensional ac gas-discharge system - self-organized solitary filaments and related DSs as well as inhomogeneities can serve as points of the Voronoi net - major mechanism: corona discharge

miscellaneous patterns  
exp: 2d-ac-GDS - concentric rings  
many body f systems  
exp: 2d-ac-GDS - liquid-like f system  
bifurcation  
exp: 2d-ac-GDS - (concentric rings) ↔ (gas-like pattern)  
detection of self-organized stationary patterns consisting of equidistant concentric rings - double break down within a half period leads to two stationary concentric ring systems that add up to a third ring system in frames with exposure time being larger than the period of the driver

hexagons in \( \mathbb{R}^2 \)  
exp: 2d-ac-GDS, - stat, rot hex pattern made of fs; without and with "vacancies" as defects, distortion of hex pattern when rotating, direction of rotation may change spontaneously, existence of patterns depends on gas temperature;  
bifurcation  
exp: 2d-ac-GDS - (stat hom) ↔ (stat hex) ↔ (stat rot perturbed); (stat hom) ↔ (stat rot perturbed)  
experimental detection of transitions to rotating hexagonal patterns with corresponding symmetry breaking in quasi 2-dimensional planar ac gas-discharge systems

Pu117: Stollenwerk, Purwins (2005)  
isolated stationary and travelling fs  
exp: 2d-ac-GDS - intrinsically stat, intrinsically trav fs with superimposed noise; experimental determination of stochastic trajectories of individual DSs  
interaction of fs: formation of molecules  
exp: 2d-ac-GDS - arrangement of fs on a ring  
hexagons in \( \mathbb{R}^2 \)  
exp: 2d-ac-GDS - hex pattern made of fs  
many f systems

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exp: 2d-ac-GDS - “liquid” and “gas-like” state; “molecular gas” with a
tendency to gen of fs at the circular boundary and annull while
drifting to the centre

bifurcation of DSs: drift bif
exp: 2d-ac-GDS - (stat DS) ↔ (trav DS)

experimental determination of trajectories of individual solitary filaments
and related DSs - application of a new stochastic data analysis method
([Pu098, Pu099]) to extract from the experimentally determined stochastic
trajectories the intrinsic speed - experimental determination of the
(subcritical) bifurcation from a stationary to a travelling solitary filaments
and related DSs - see also in: AC Gas-Discharge Systems: Experiment
and Reaction-Diffusion Equations


hexagons in R^2
exp: 2d-ac-GDS - evolution (transients) after switching on the driving
ac voltage: (stat hom) → (concentric ring near to the boundary)
→ (washed out spot) → (hex pattern made of fs)

theo: 3d-ac-GDS, using a gas-discharge specific drift-diffusion model
in R^3 with parameters taken from experiment: evolution
(transient) after switching on the driving ac voltage: (stat hom)
→ (concentric ring near to the boundary) → (washed out sport)
→ (hex pattern made of fs), (quant)

after switching on the discharge: experimental observation of the
transients to an ensemble of hexagonally arranged solitary filaments and
related DSs with neighbouring distance of order of their diameter - first
quantitative theoretical reproduction of the experimentally observed
patterns without parameter fitting - see also: Gas-Discharge: Theory


isolated stationary and travelling fs
exp: 2d-ac-GDS - stat, trav fs, trajectories with
superimposed noise, mobility depends on surface humidity

generation of fs: due to interaction
exp: 2d-ac-GDS - two fs collide and vanish

many body LS- (DS-)systems
exp: 2d-ac-GDS - dry surface: stat dense arrangement of fs; wet
surface with gas like initial condition generated above ignition
voltage, after lowering the voltage below ignition: (dynamic
gas-like arrangement of fs) → (decrease of number of fs due to
collision) → (few fs with seemingly stochastic trajectories) →
typically 1-3 fs come to a rest, fs come to a rest at positions
that have been visited rather often before

hexagons in R^2
exp: 2d-ac-GDS - wet surface, in the course of time: dynamic
approximate hex arrangement of fs gradually freezed out to a
stat pattern

observation of irregular trajectories of isolated solitary filaments and
related DSs in a quasi 2-dimensional ac gas-discharge system -
detection of a memory effect - proposition of a new mechanism for the
propagation of isolated solitary filaments and related DSs involving surface
humidity of the electrodes
Pu127: **Purwins, Amiranashvili (2007)**

- **Summary** - Simple patterns: e.g., isolated filaments, stripes, hexagons, and rotating spirals - patterns of higher complexity with solitary filaments and related DSs as elementary building blocks: e.g., “molecules” and “many body systems” in the form of crystal-, liquid-, gas-like arrangements, chains, and nets - universal experimental behaviour for a certain class of systems containing planar ac and dc gas-discharge systems, electrical networks, semiconductor layer systems, chemical solutions, and biological systems - theoretical definition of the corresponding universality class by writing down a 3-component reaction-diffusion system serving as a kind of normal form for the qualitative description of the experimentally observed self-organized patterns - illustration of the formation of solitary filaments and related DSs in planar electrical transport systems on the basis of the 2-component reaction-diffusion equation - see also: *Electrical Networks: Experiment and Theory, DC Gas-Discharge Systems: Experiment, Gas-Discharge: Theory, Semiconductors: Experiment, Semiconductors: Theory, Reaction-Diffusion Equations*

Pu128: **Stollenwerk, Gurevich, Laven, Purwins (2007)**

- **Isolated Stationary and Travelling FSs**
  - Exp: 2d-ac-GDS - Intrinsically stat, or slowly drifting bright (on a dark background) and dark fs (on a bright background); simultaneous existence of the former with bright and dark periodic stripes respectively
  - Theo: 2-k + gc, R¹ - Qualitative reproduction of the experimental phenomena

- **Many FS Systems**
  - Exp: 2d-ac-GDS - Dense arrangement of fs
  - Theo: 2-k + gc, R¹ - Qualitative reproduction of the experimental phenomena

- **Stripes in R²**
  - Exp: 2d-ac-GDS - Periodic stripes
  - Theo: 2-k + gc, R¹ - Qualitative reproduction of the experimental phenomena

- **Miscellaneous Non FS Patterns**
  - Exp: 2d-ac-GDS - Dense arrangement of fs and stripes on the same domain; domain fully covered with stripes
  - Theo: 2-k + gc, R¹ - Qualitative reproduction of the experimental phenomena

- **Bifurcation of FSs Including Snaking**
  - Exp: 2d-de-GDS, R₀ ≠ 0 - (Stat hom dark) ↔ (isolated bright f) ↔ (dense arrangement of bright fs) ↔ (simultaneous existence of dense arrangement of bright fs with periodic bright stripes) ↔ (periodic bright stripes/periodic dark stripes) ↔ (simultaneous existence of dense arrangement of dark fs with periodic dark stripes) ↔ (simultaneous existence of dense arrangement of dark fs with dark periodic stripes) ↔ (dense arrangement of dark fs) ↔ (isolated dark fs) ↔ (Stat hom bright)
  - Theo: 2-k + gc, R¹ Qualitative reproduction of the experimental phenomena

*Experimental observation of the following bifurcation scenario in a quasi 2-dimensional ac gas-discharge system: (Stat hom dark) ↔ (isolated bright solitary filaments and related DSs) ↔ (dense arrangement of bright...*
solitary filaments and related DSs) ↔ (simultaneous existence of dense arrangement of bright solitary filaments and related DSs together with periodic bright stripes) ↔ (periodic bright stripes/periodic dark stripes) ↔ (simultaneous existence of dense arrangement of dark solitary filaments and related DSs together with periodic dark stripes) ↔ (isolated dark solitary filaments and related DSs) ↔ (stat hom bright) - qualitative reproduction of the foregoing scenari by the solutions of the 2-component reaction-diffusion system - see also: Reaction-Diffusion Equations

Pu129: Stollenwerk, Amiranshvili, Purwins, Boeuf, Purwins (2007) isolated stationary and travelling fs
exp: 2d-ac-GDS - stat, slowly drifting fs
theo: 2d-ac-GDS - using a gas-discharge specific drift-diffusion model in R³ (one coordinate vertical to the electrodes and two parallel) with parameters taken from experiment: - period pattern in the direction parallel to the electrode consisting of fs, semi-quantitative description of an isolate filament bifurcation of fs
exp: 2d-ac-GDS - (stat hom dark) → (by increasing the driver amplitude) → (dense arrangement of fs) → [by decreasing the driver amplitude] → (gradually decreasing number of fs) many f systems
exp: 2d-ac-GDS - dense arrangement of fs first semi-quantitative theoretical reproduction of single stationary solitary filaments and related DSs in a quasi 2-dimensional ac gas-discharge system using the drift diffusion approximation using no parameter fitting - continuation of \[Pu067, Pu123 - see also: Gas-Discharge: Theory\]

Pu130: Stollenwerk, Larven, Purwins (2007) development of a new method to measure the surface charge in dielectric barrier discharge based on the Pockels effect - first measurement of the surface charge distribution related to the formation of isolated and dense solitary filaments (and related DSs) in a dielectric barrier discharge system

Pu131: Purwins (2007) summary - stressing that the formation of solitary filaments and related DSs in planar low temperature dc and ac gas-discharge systems is a generic phenomenon - stressing that in many respect solitary filaments and related DSs behave like particles - illustration of the formation of DSs in planar electrical transport systems on the basis of the 2-component reaction diffusion equation - considered experimentally observed phenomena: e.g isolated DS, snaking, bifurcation from stationary to travelling DSs, mutual interaction of DSs with scattering, “molecule” formation, generation and annihilation as well as “many body systems” in the form of crystal-, liquid-, gas-like arrangements, domain structures and chains and nets - pointing out that the 3-component reaction-diffusion system seems to present a kind of normal form for the qualitative
description of self-organized patterns in the discussed gas-discharge systems - listing of potential applications - see also: DC Gas-Discharge Systems: Experiment, Gas-Discharge: Theory, Reaction-Diffusion Equations