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

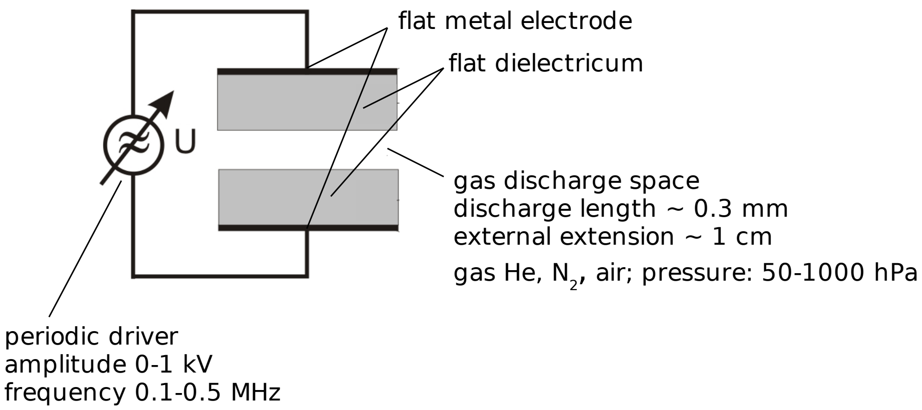

Fig. 5.1

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.

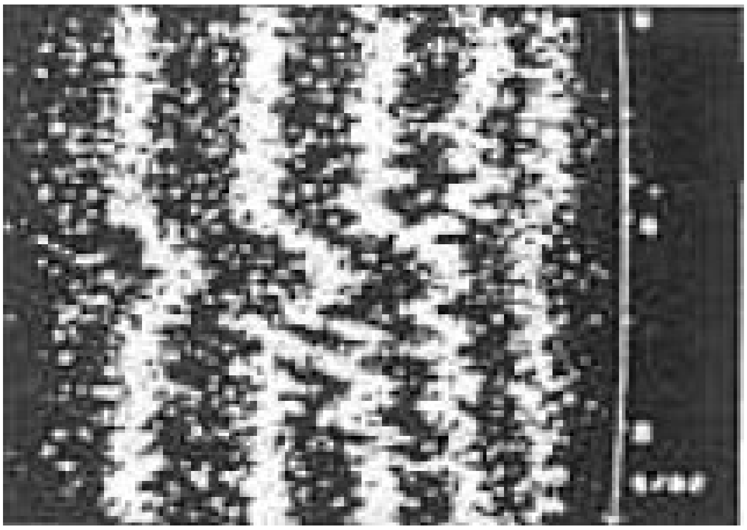

Fig. 5.2

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

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A 5.3 Listing of main results

With respect to the abbreviations used in the following listing of observedphenomena 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 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 planar gas-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 planar gas-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

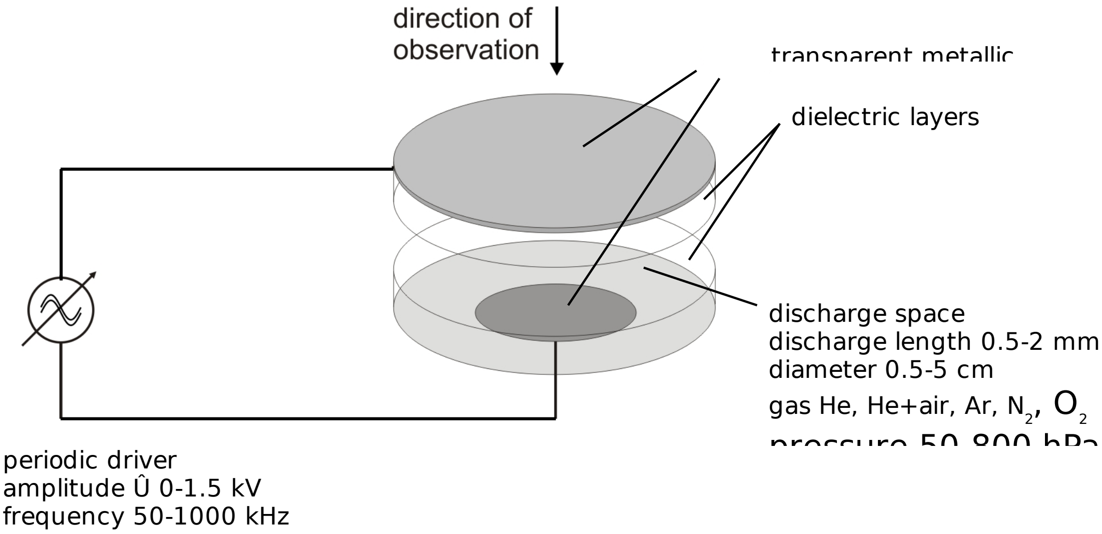

Fig. 5.3

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.

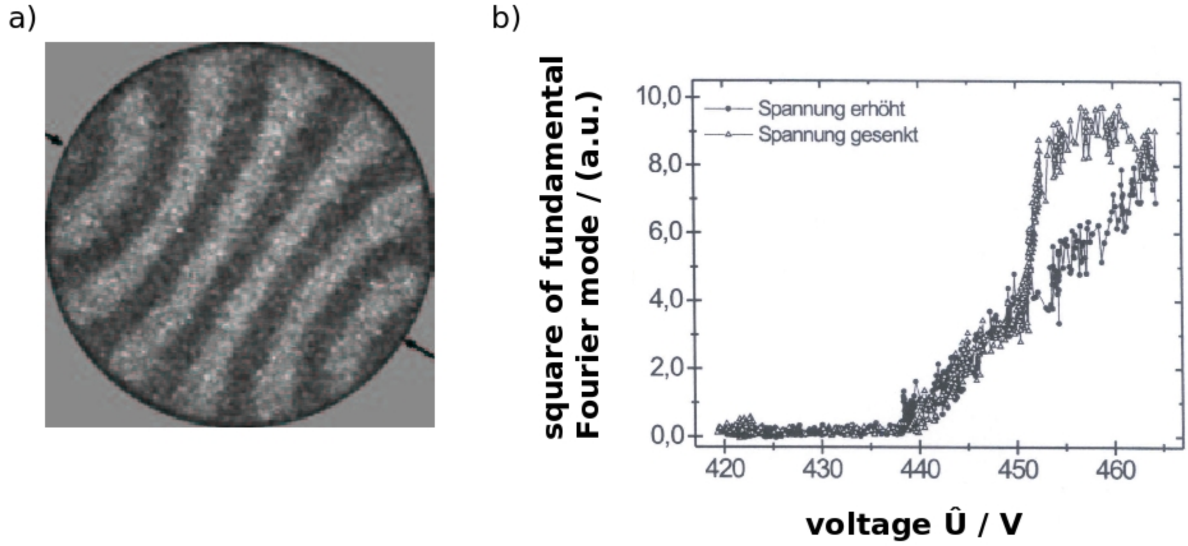

Fig. 5.4a,b

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 Barrierenentladungen", 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]

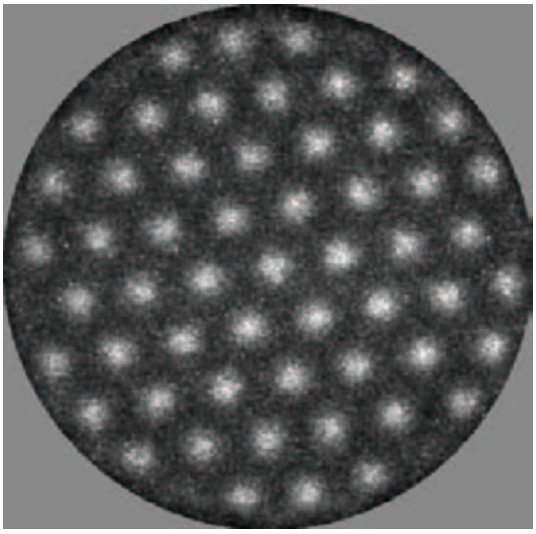

Fig. 5.5

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]

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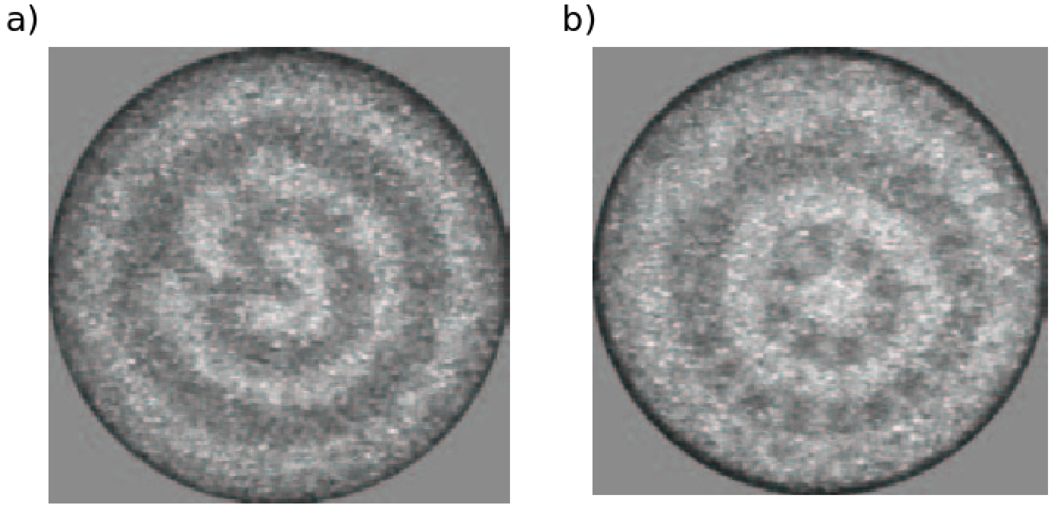

Fig. 5.6a,b

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]

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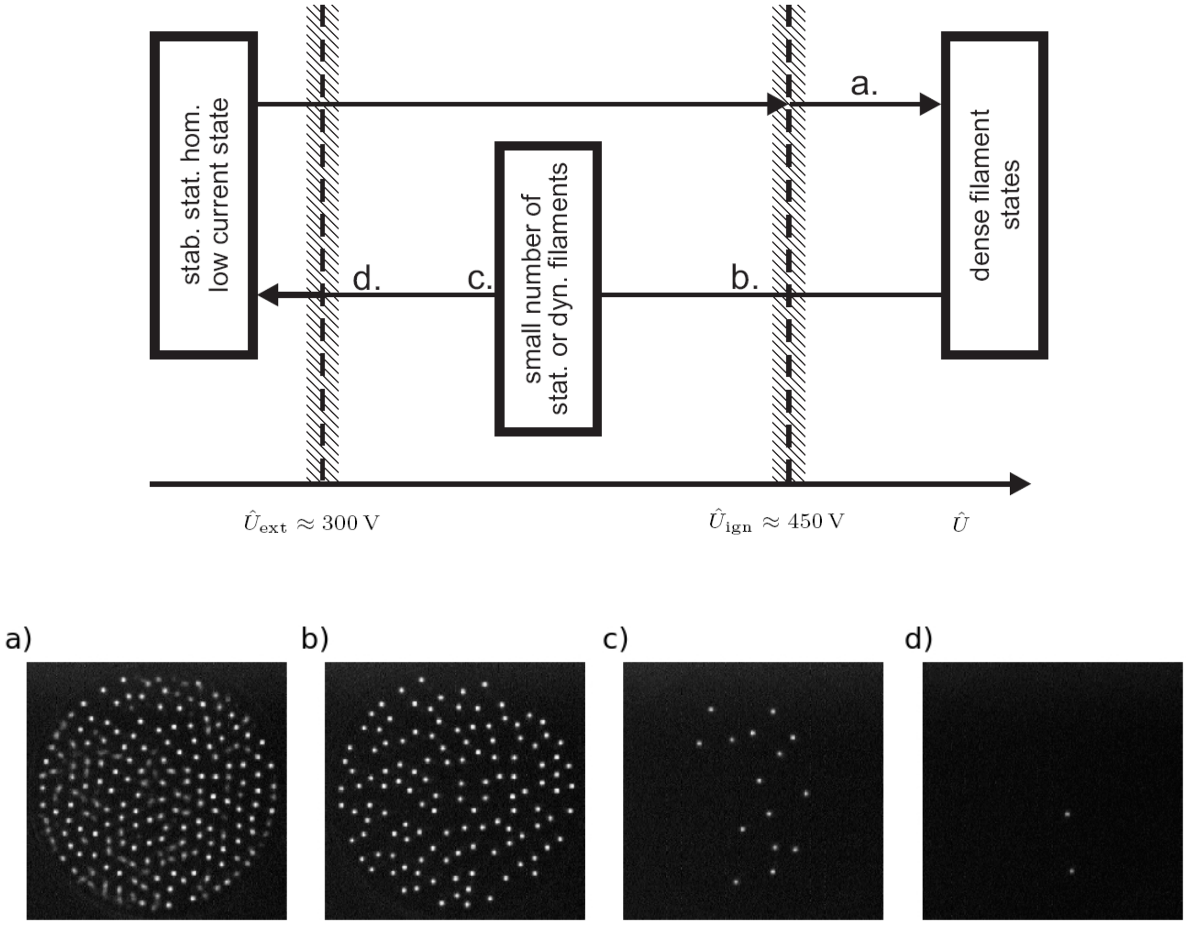

Fig. 5.7a-d

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, Amiranasvili, 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]

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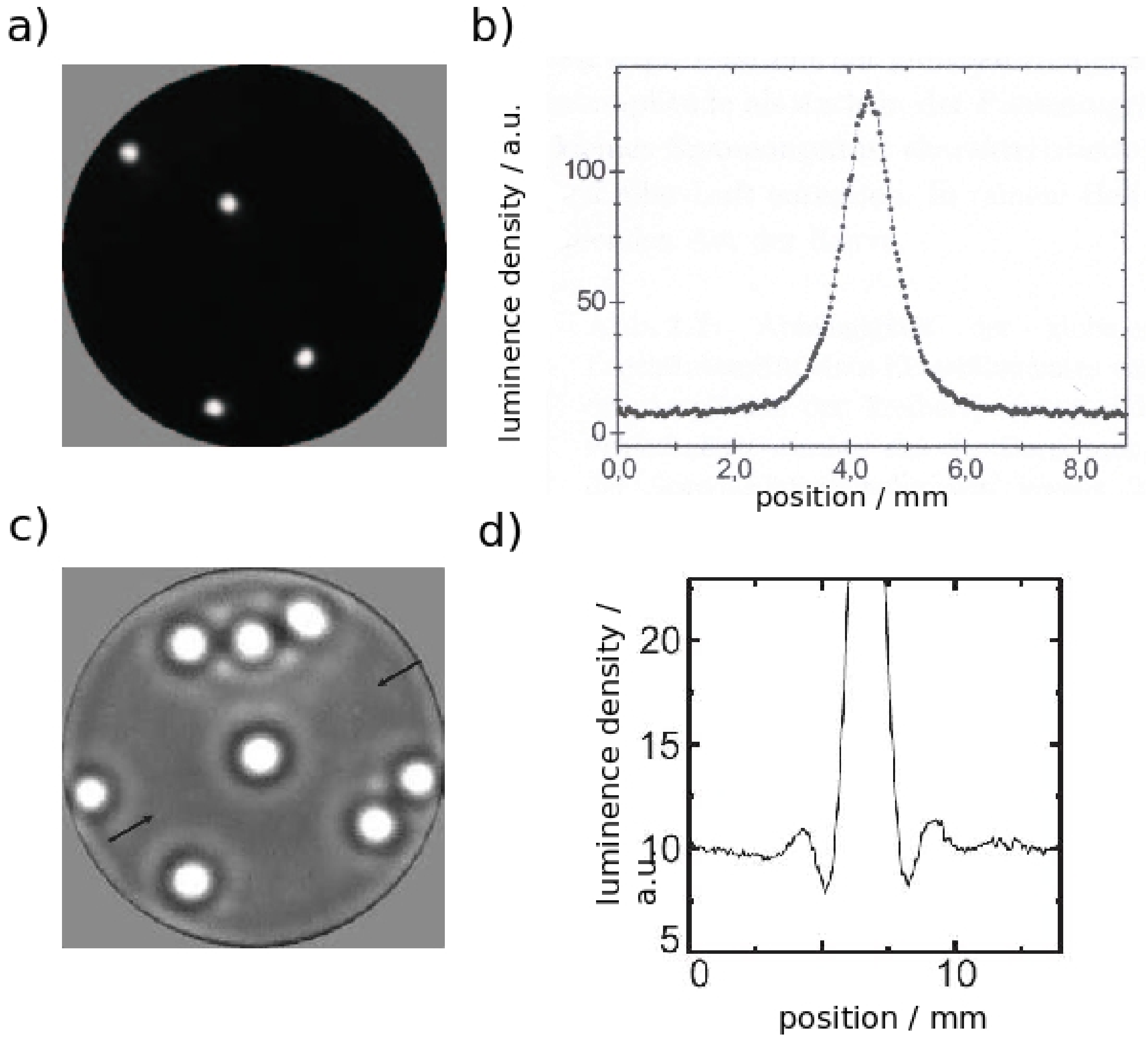

Fig. 5.8a-d

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]

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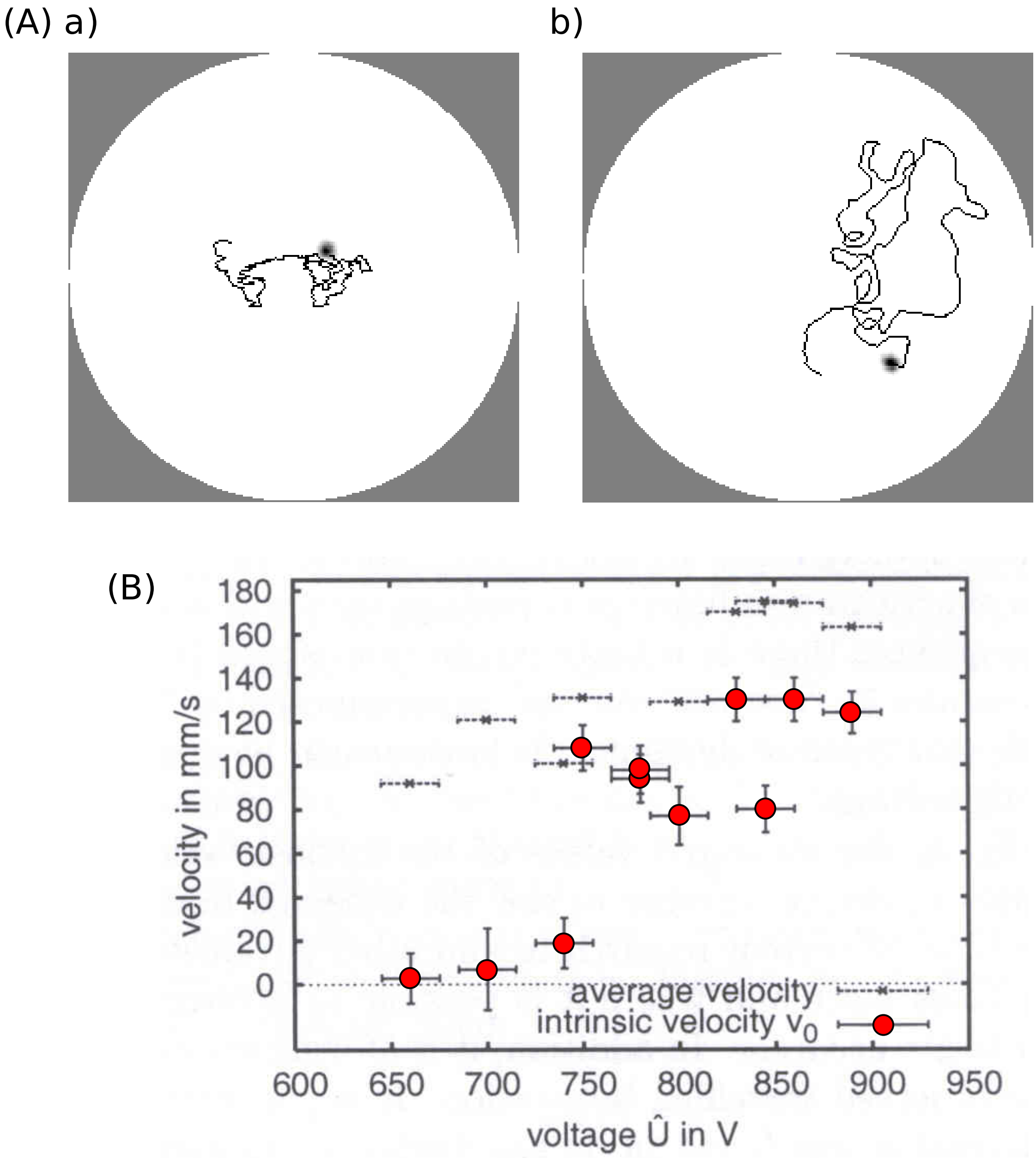

Fig. 5.9A,B

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

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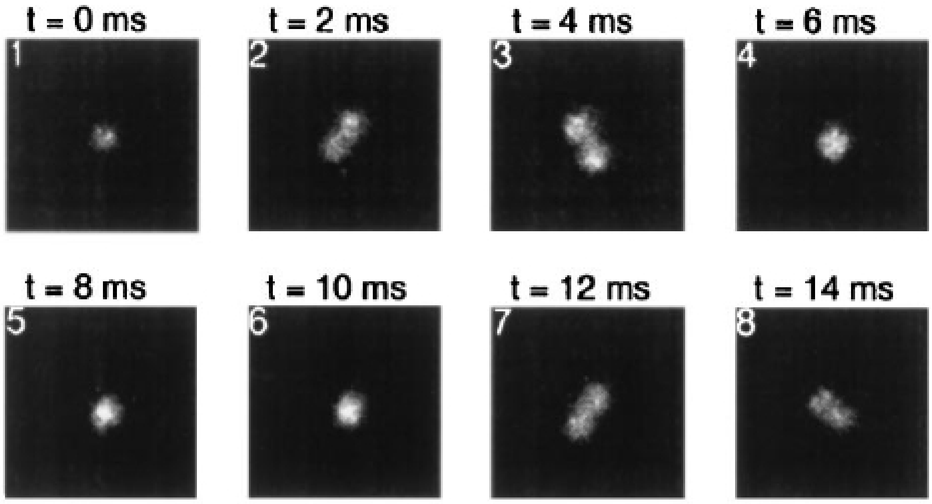

Fig. 5.10

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)]

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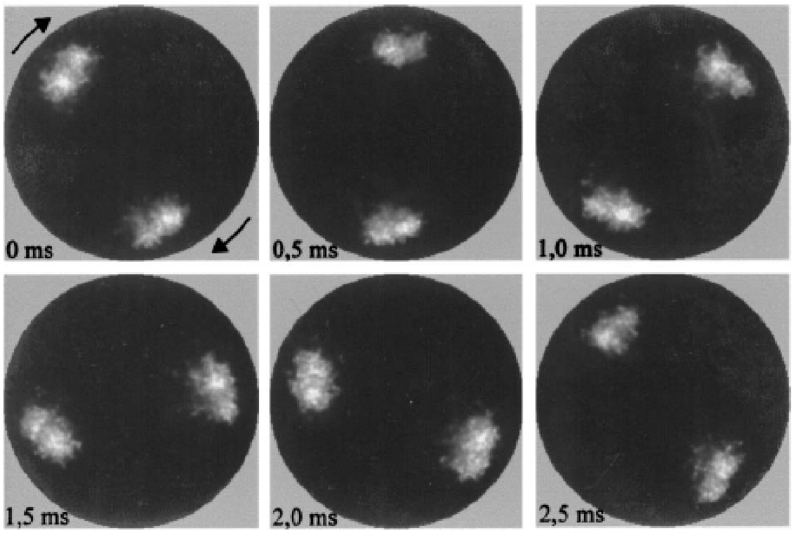
a)



b)

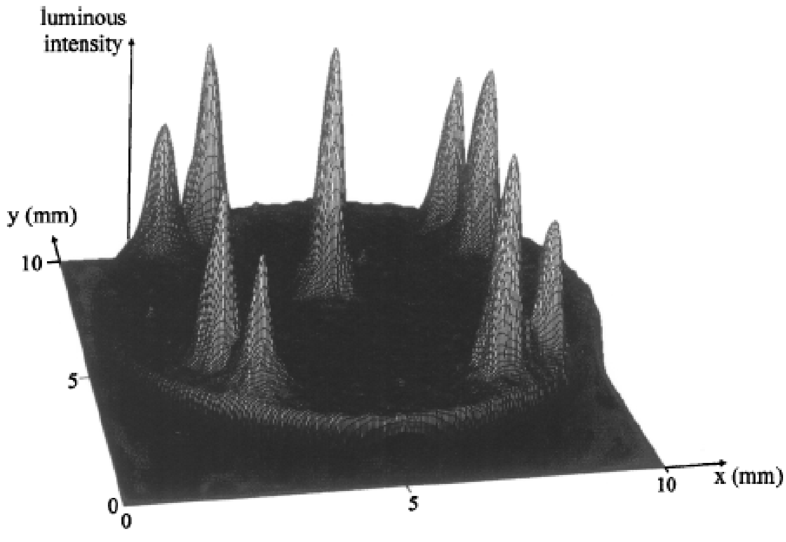


Fig. 5.11a,b

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]

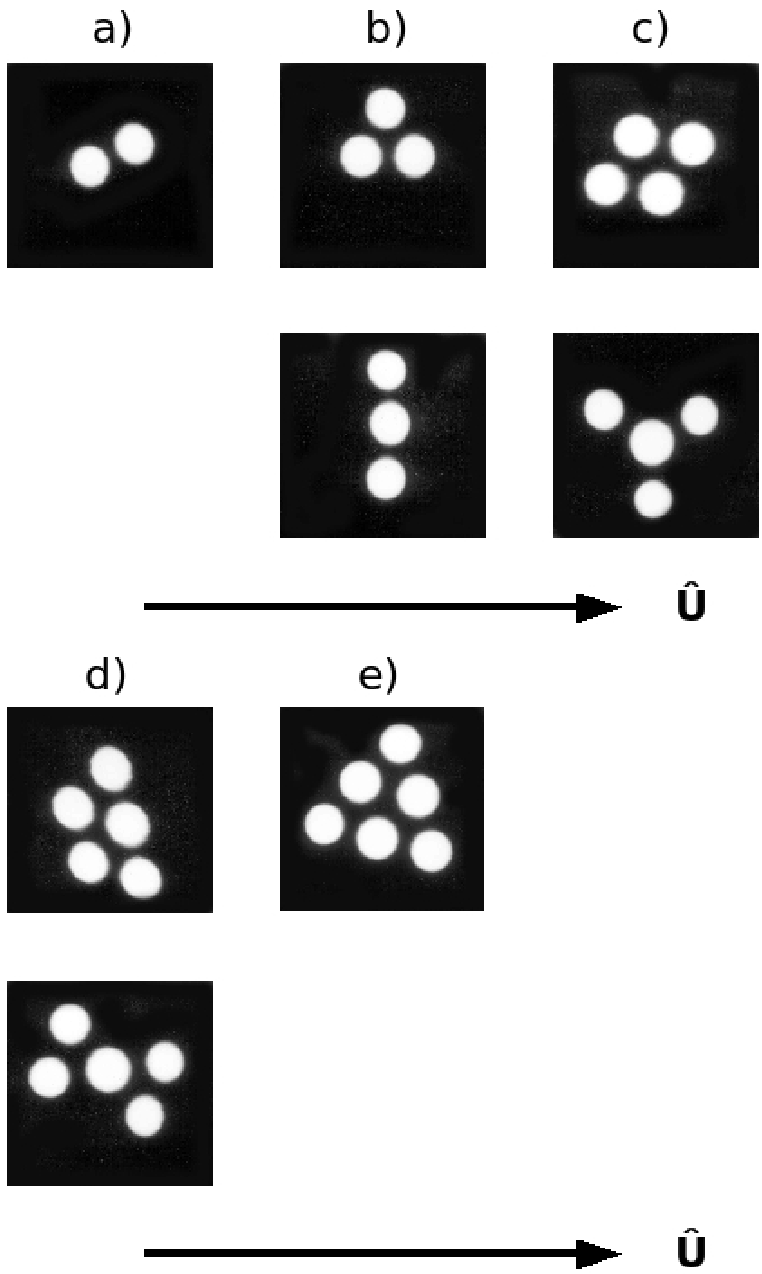


Fig. 5.12a-e

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]

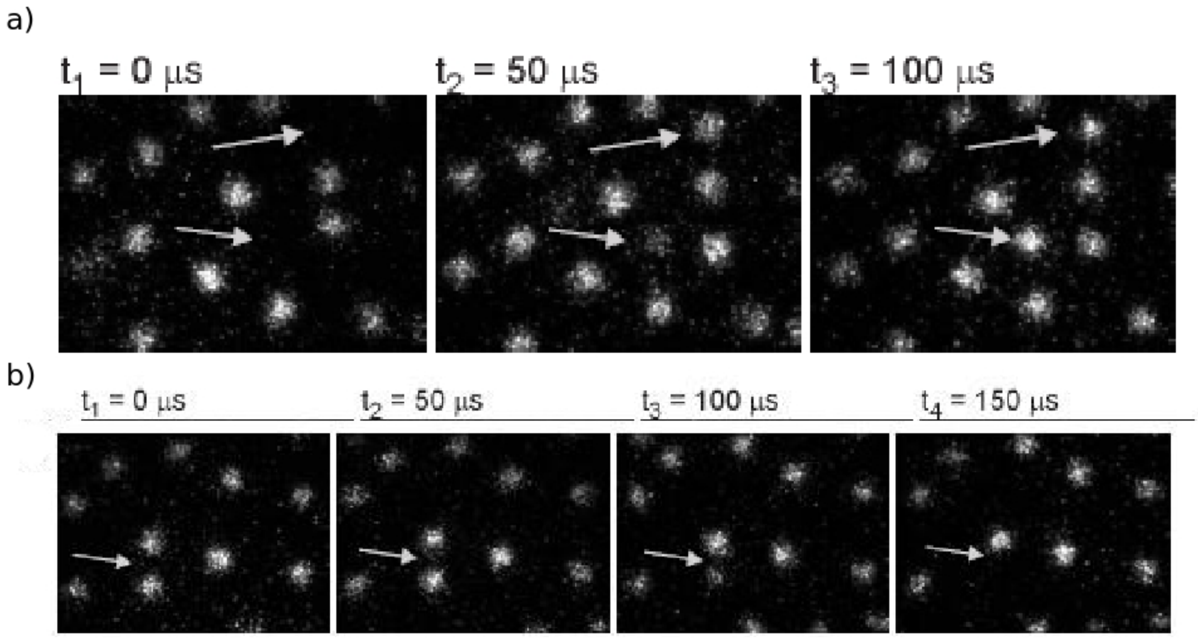


Fig. 5.13a,b

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

a)

b)

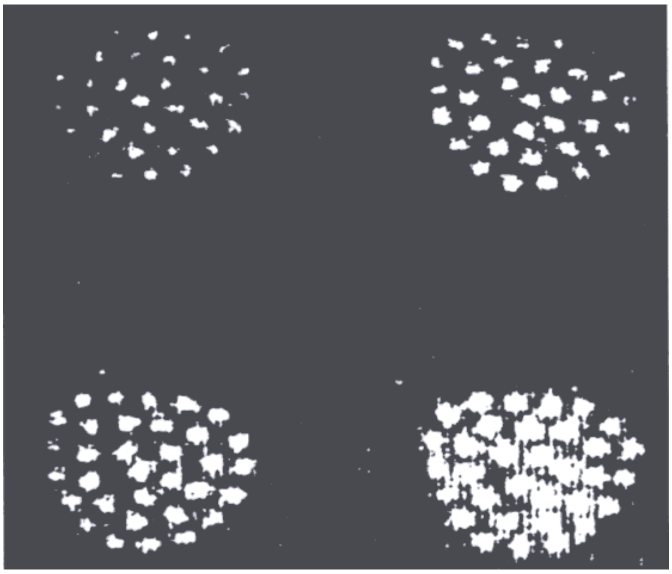


Fig. 5.14a,b

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]

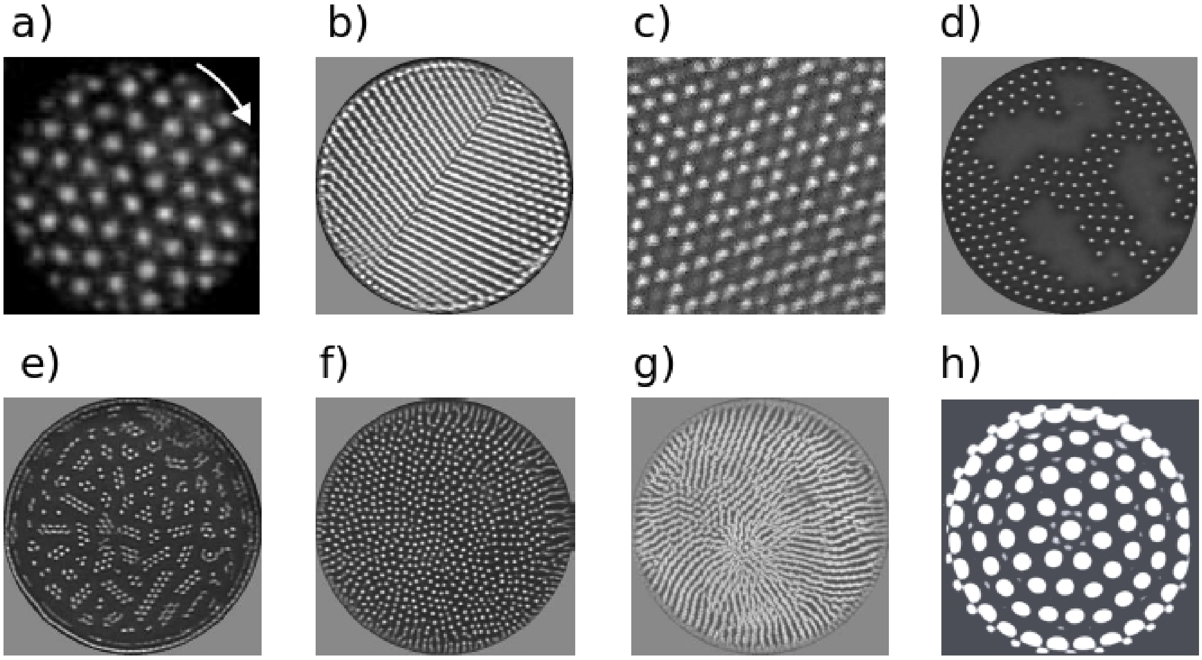


Fig. 5.15a-h

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]

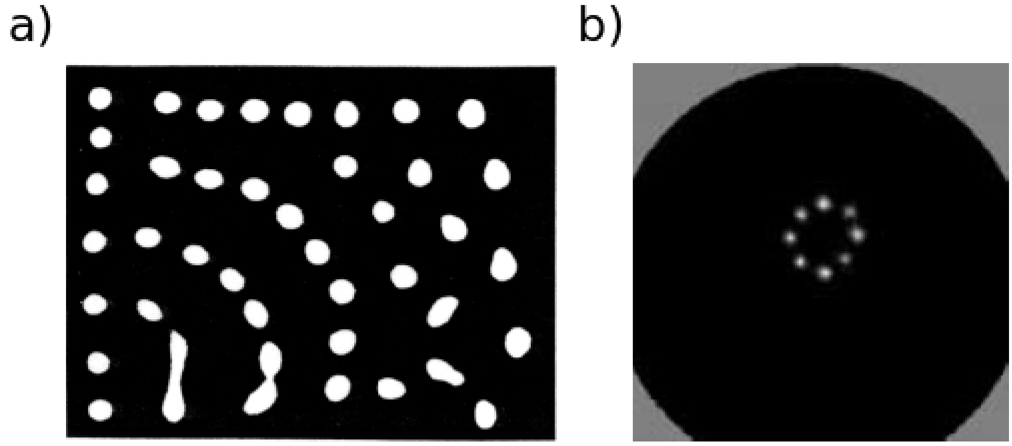


Fig. 5.16a,b

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

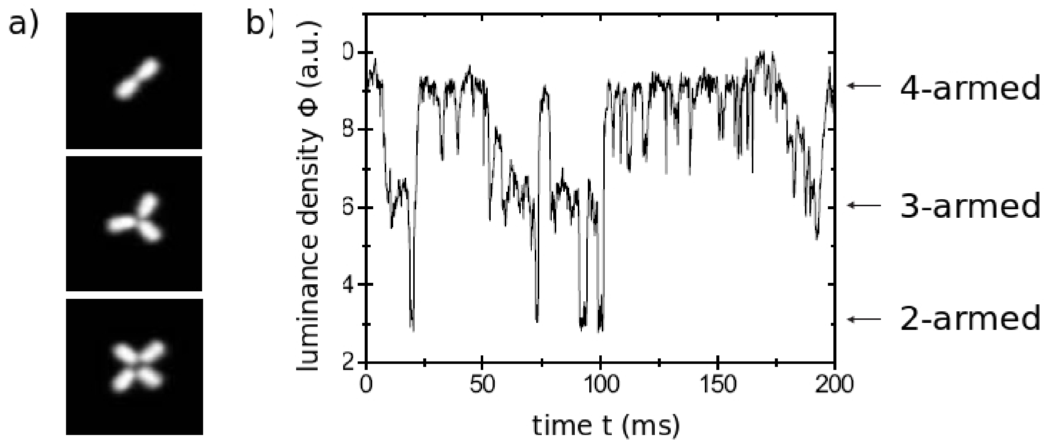


Fig. 5.17a,b

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 Φ as a function of time (b). [I. Brauer, Thesis (2000)]

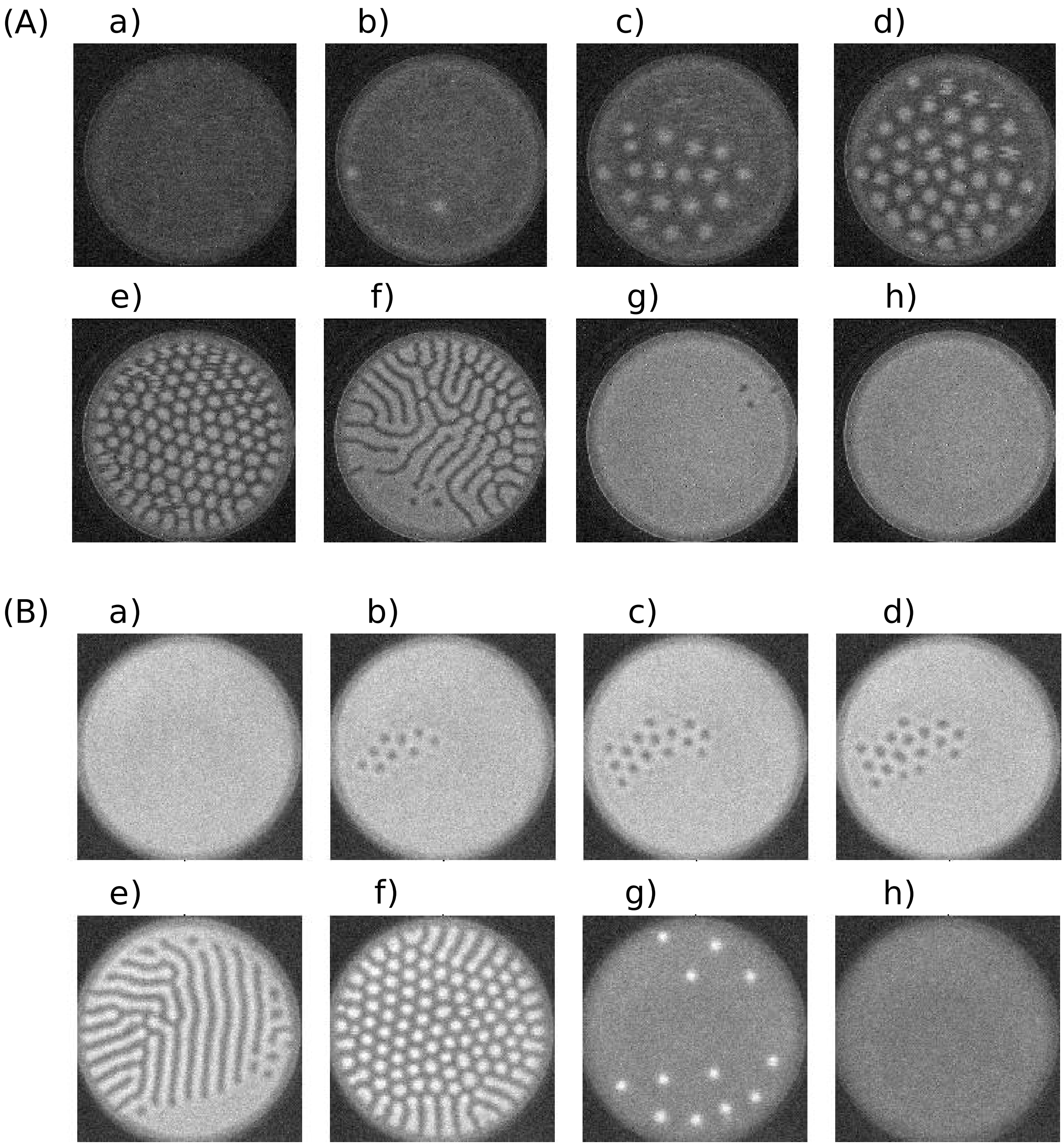


Fig. 5.18A, B

(C)

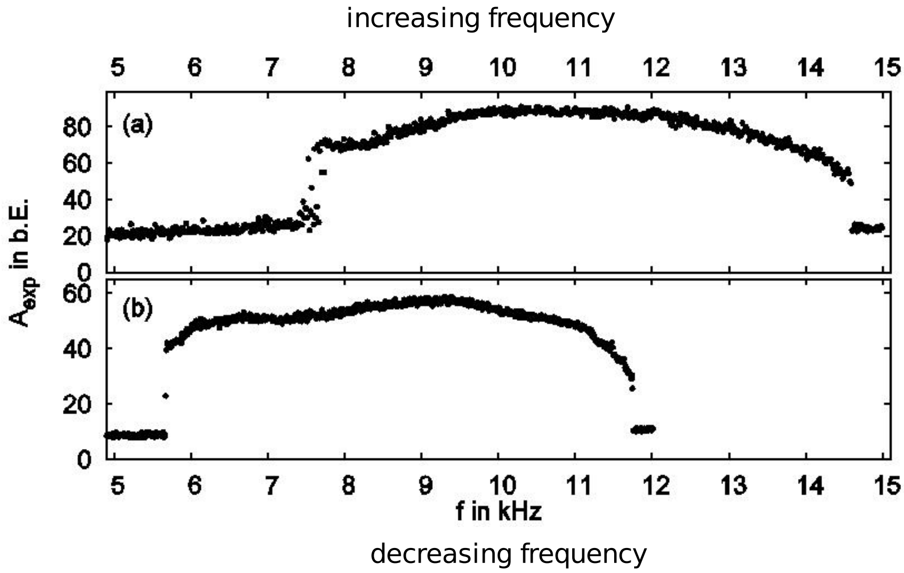


Fig. 5.18A-C

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

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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 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-dimensionl gas-dischargesystems - solitary filaments and related DSs rotating on closed loops - many solitary filament and related DSs systems : equidistantly arranged on rot concentric rings with adjacent rings that may rotate in opposite direction

Pu046: **Or-Guil, Ammelt, Niedernostheide, Purwins (1995)**

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 R^2

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

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

isolated stationary and travelling DSs

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

many f 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 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 foreword drift-diffusion approximation - **see also: Gas-Discharge: Theory**

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: hex domains 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

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 DS 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

Pu090: **Zanin, Liehr, Moskaleno, Purwins (2002)**
experimental detection of self-organizd Voronoi diagrams in a quasi 2-dimensional ac gas-dischargesystem - self-organized solitary filaments and related DSs as well as inhomogeneitiescan serve as points of the Voronoi net - major mechanism: chorona discharge

Pu104: **Gurevich, Zanin, Moskaleno, Purwins, (2003)**
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-organizd 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

Pu112: **Zanin, Gurevich, Moskalenko, Moskalenko, Bödeker, Purwins (2004)**
hexagons in 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 hon) ↔ (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 R^2
exp: 2d-ac-GDS - hex pattern made of fs
many f systems

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

Pu123: Stollenwerk, Amiranshvili, Boeuf, Purwins (2006)

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 sport) → (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 - <u>first quantitative theoretical reproduction of the experimentally observed patterns without parameter fitting</u> - see also: Gas-Discharge: Theory

Pu125: Stollenwerk, Amiranshvili, Purwins (2006)

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 - <u>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</u>

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 fs

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, R^1 - qualitative reproduction of the experimental phenomena

many f systems

exp: 2d-ac-GDS - dense arrangement of fs

theo: 2-k + gc, R^1 - qualitative reproduction of the experimental phenomena

stripes in R^2

exp: 2d-ac-GDS - periodic stripes

theo: 2-k + gc, R^1 - qualitative reproduction of the experimental phenomena

miscellaneous non f patterns

exp: 2d-ac-GDS - dense arrangement of fs and stripes on the same domain; domain fully covered with stripes

theo: 2-k + gc, R^1 - qualitative reproduction of the experimental phenomena

bifurcation of fs including snaking

exp: 2d-dc-GDS, $R_0 \neq 0$ - (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, R^1 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) ↔ (simultaneous existence of dense arrangement of dark solitary filaments and related DSs together with dark periodic stripes) ↔ (dense arrangement of dark solitary filaments and related DSs) ↔ (isolated dark solitary filaments and related DSs) ↔ (stat hom bright) - qualitative reproduction of the foregoing scenarion 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 R^3 (one coordinate vertical to the electrodes andtwo 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 acgas-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